

Systematic Botany

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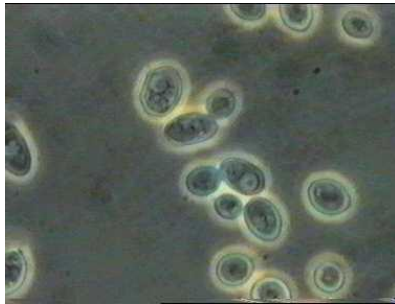
Fungi

(Mycophyta)

1- General Characters

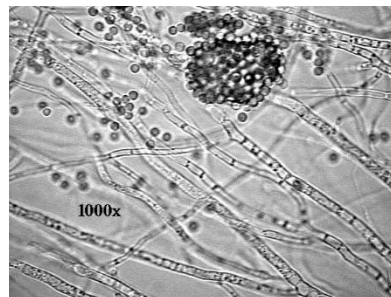
- 1- Eukaryotic Organisms (i.e true nucleus)
- 2- Non-Vascular Organisms and not differentiated into roots, stems or leaves. Thus they are thallophytes
- 3- Non-motile except few fungi
- 4- Vegetative body may be:

unicellular

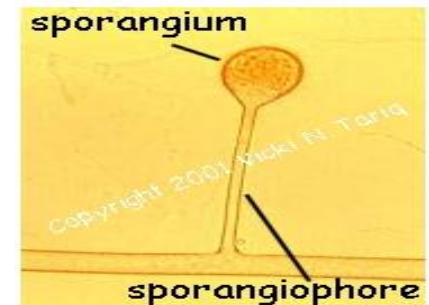


Filamentous

Septated



Non-Septated



5- Cell wall similar in structure of plant but differ in chemical composition:

Plant C.W.	Cellulose + other components
Fungi C.W.	Chitin

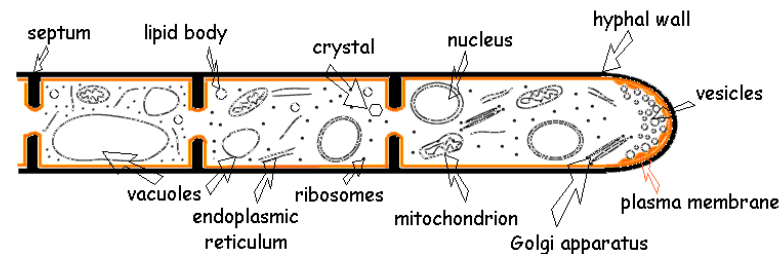
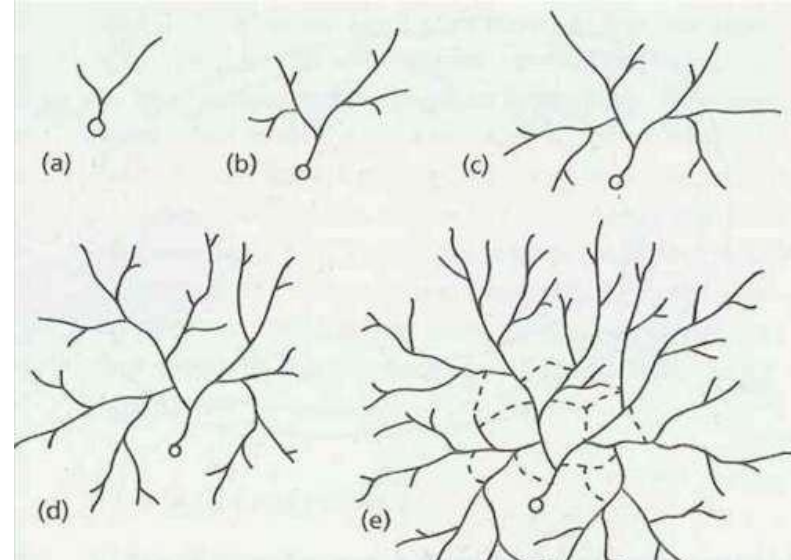
6- Fungi are Heterotrophic organisms

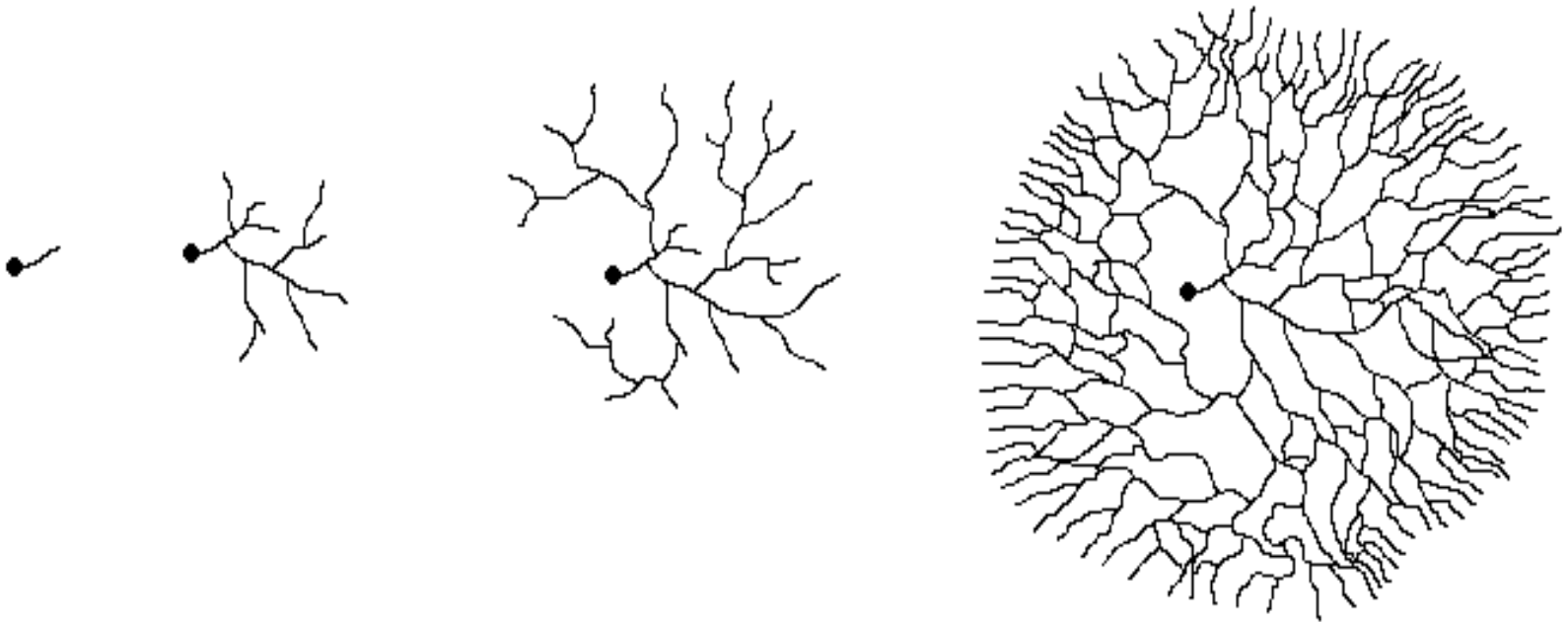
7- Growth by apical elongation of hyphal tip

8- Food stored as glycogen but plant as starch

The Body of a Fungus

- Fungi exist mainly in the form of slender filaments (**hyphae**).
 - long chains of cells joined end-to-end divided by cross-walls (**septa**)
 - rarely form complete barrier
 - cytoplasm freely streams in hyphae
 - **mycelium** - mass of connected hyphae
 - grows through and penetrates substrate





mycelium

Mycelia have a huge surface area

9- Fungi produce exoenzymes to digest food then ingest it .

10- Reproductive Structures are differentiated from somatic structures. .

11- Reproduction

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graph TD; A[11-Reproduction] --> B[Sexual]; A --> C[Asexual]; A --> D[Vegetative];
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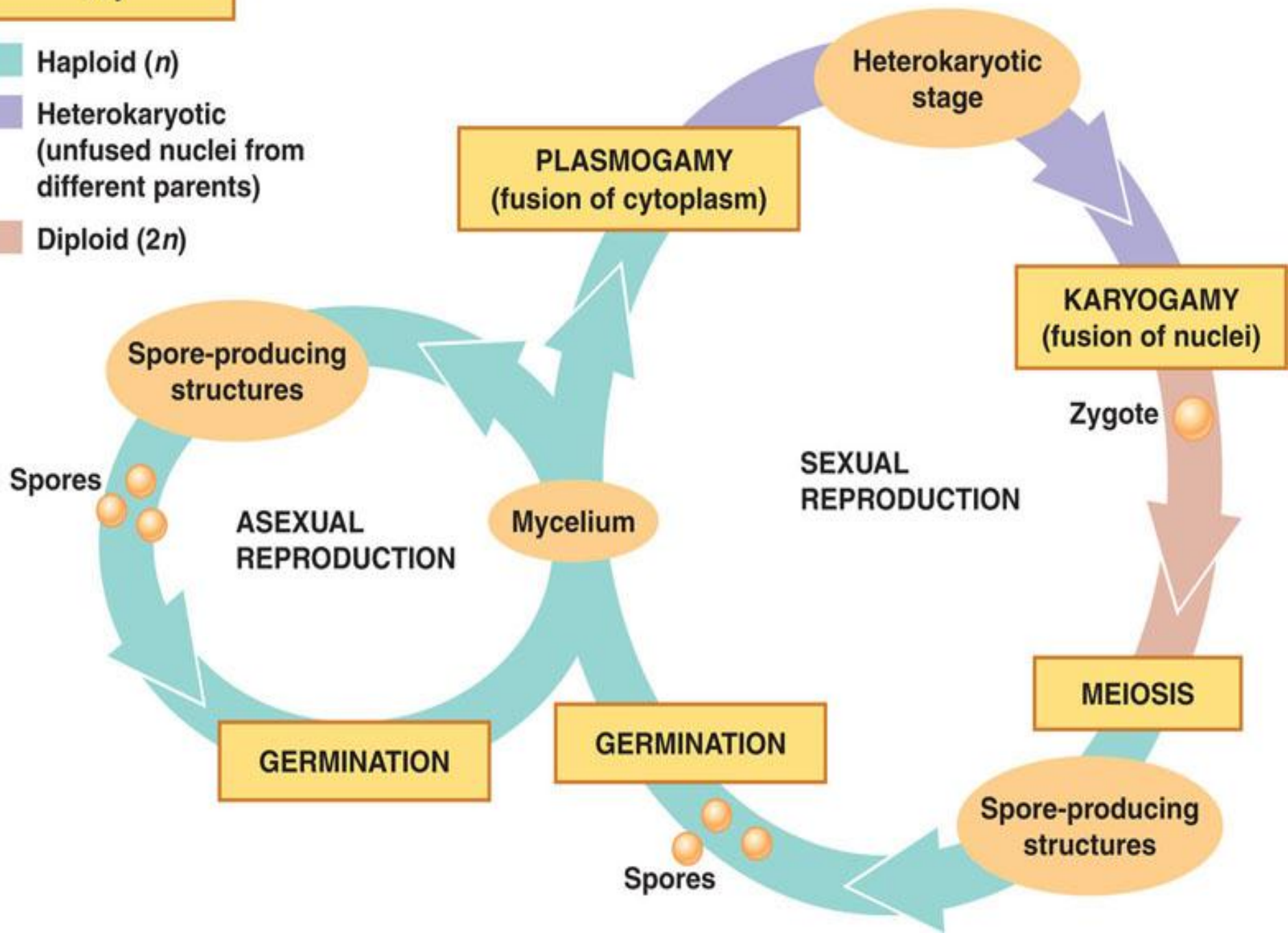
Sexual

Asexual

Vegetative

Key

- Haploid (n)
- Heterokaryotic (unfused nuclei from different parents)
- Diploid ($2n$)



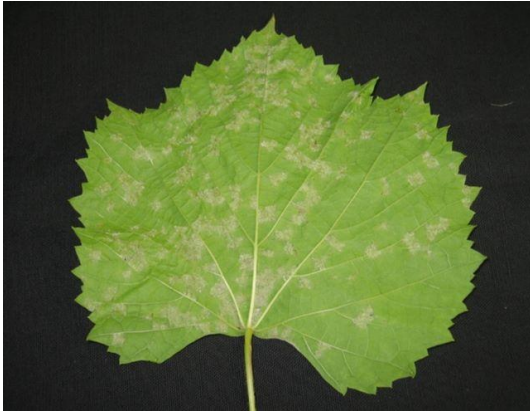
12- Nutrition in fungi

(mod of living)

- **Saprophytes** : 1- use non - living organic materials
2- important in recycling C,N
and essential mineral nutrients



• **Parasites** : 1- use organic materials from living organisms , causing diseases to them



2- they have a wide range of hosts as: plants, animals and human .

• **Symbiotic** : 1- fungi that have a beneficial symbiotic relationship with other living organisms



Ex :

Mycorrhizae

Lichens

Mycorrhizae

It is associations of fungi with plant roots

•**Types of Mycorrhizae :**

Ectomycorrhizae

- Fungus form a sheath around the root with hyphal grow through the soil which increase the surface area
- Fungus penetrate between cells of cortex
- Ex. Basidiomycota and Ascomycota

Endomycorrhizae

- Fungus doesn't form sheath around the roots
- Fungus penetrate the cells of cortex without penetrating the cell membrane
- Ex. Zygomycota

13- Economic Importance

Useful

- Yeast Bakeries
- Antibiotics penicillin
- Steroids and Hormons
- Cheeses
- Source of food (mushroom)

Harmful

- Cause human, animal, plant diseases directly or their toxins
- Cause rot of food
- Can destroy manufactured goods

14- Reproduction

- *Types of reproduction :*

Sexual

Asexual

vegetative

a. Sexual:

- Involve the union of two compatible nuclei with a subsequent meiotic division
- All sexual fungal life cycles consists of :

plasmogamy

karyogamy

meiosis

Cell fusion

Nuclear fusion

2N

1N

15- Classification of fungi

Kingdom: Mycota

Subkingdom: Myxomycota

(Slime moulds)

- The vegetative phase is plasmodium

Subkingdom: Eumycota

(True Moulds)

- Classified according to the method of sexual reproduction

•Classification of true moulds (Eumycota)

1- *Oomycota*

Class: Oomycetes

2- *Zygomycota*

Class: Zygomycetes

3- *Ascomycota*

Class: Ascomycetes

5- *Deuteromycota*

Class: Deuteromycetes

4- *Basidiomycota*

Class: Basidiomycetes

1- Class: **Oomycetes**

General characters

1. Mostly parasitic with intracellular haustoria.
2. Narrow diameter hyphae.
3. Trend towards terrestrial habitats
 - a. Loss of primary zoospore stage
 - b. Trend towards loss of secondary zoospore stage.
4. Inability to synthesize sterols.

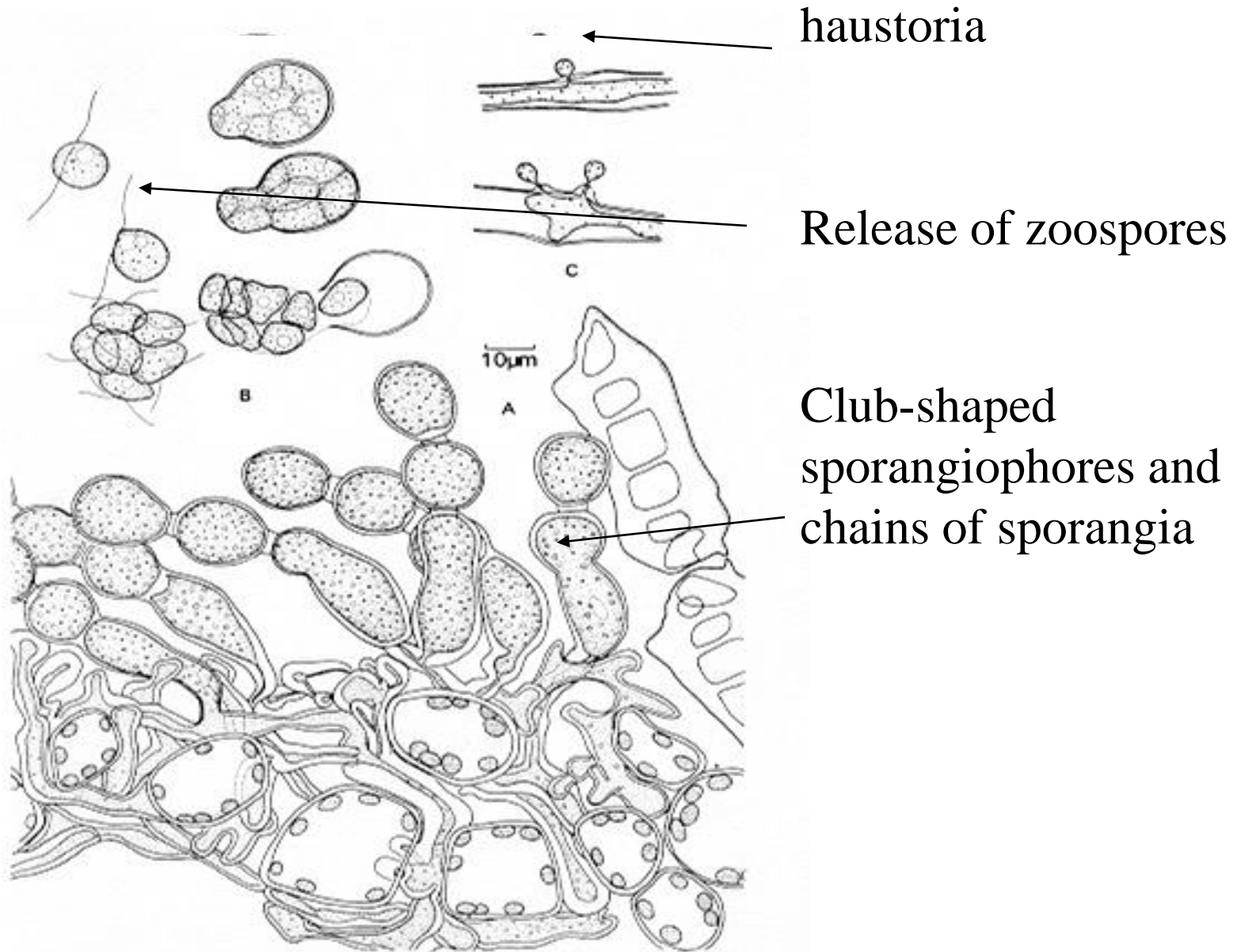
White Rust of Crucifers Caused by *Albugo candida*

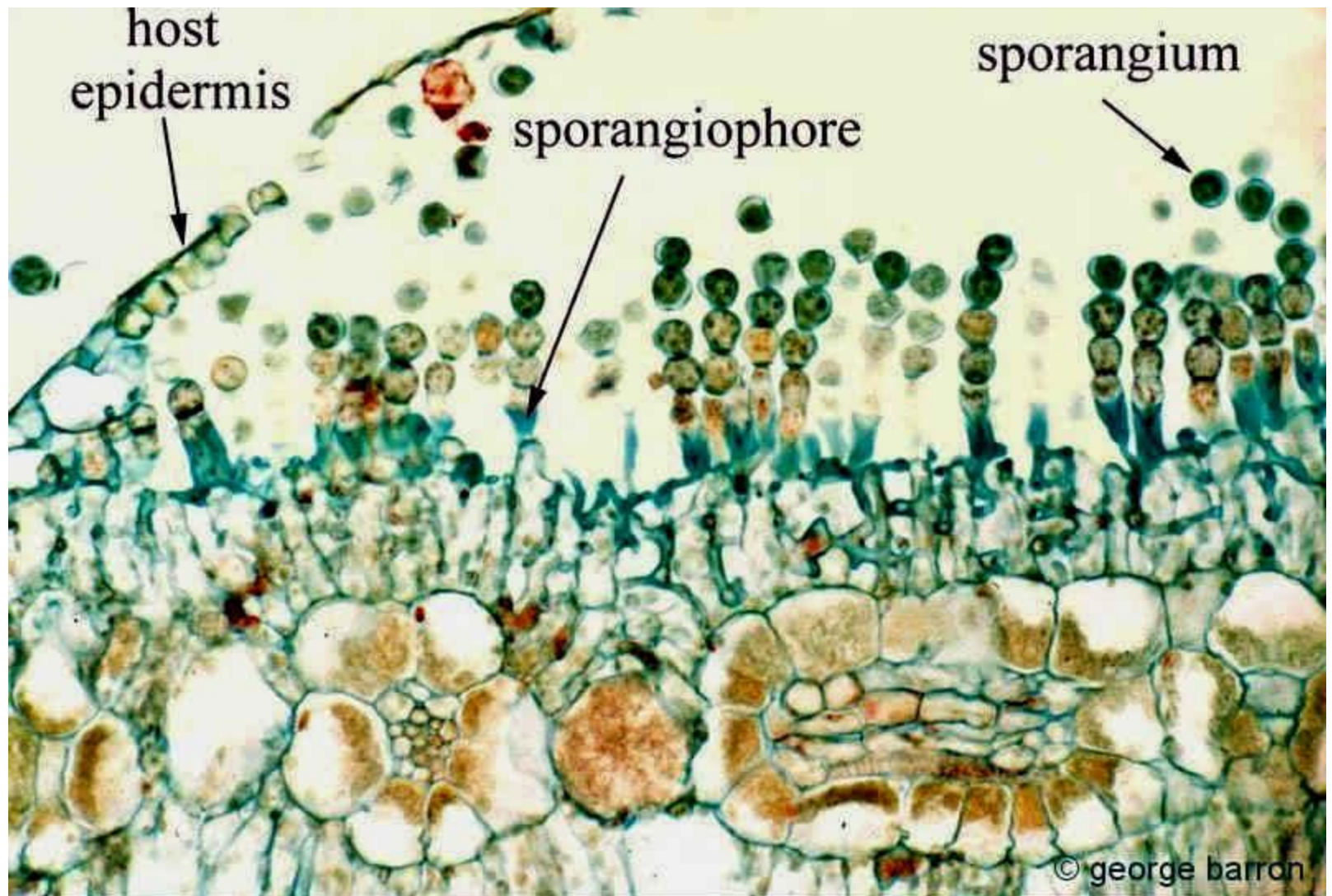
Host: *Portulaca* نبات الرجلة

- Symptoms of White Rust on Shepherd's Purse



Albugo





Albugo candida

Systematic position:

Kingdom: Mycota

Sub-kingdom: Eumycota

Class: Oomycetes

Order: Peronosporales

Family: Albuginaceae

Genus: *Albugo*

species: *candida*

2- Class: **Zygomycetes**

General characteristics

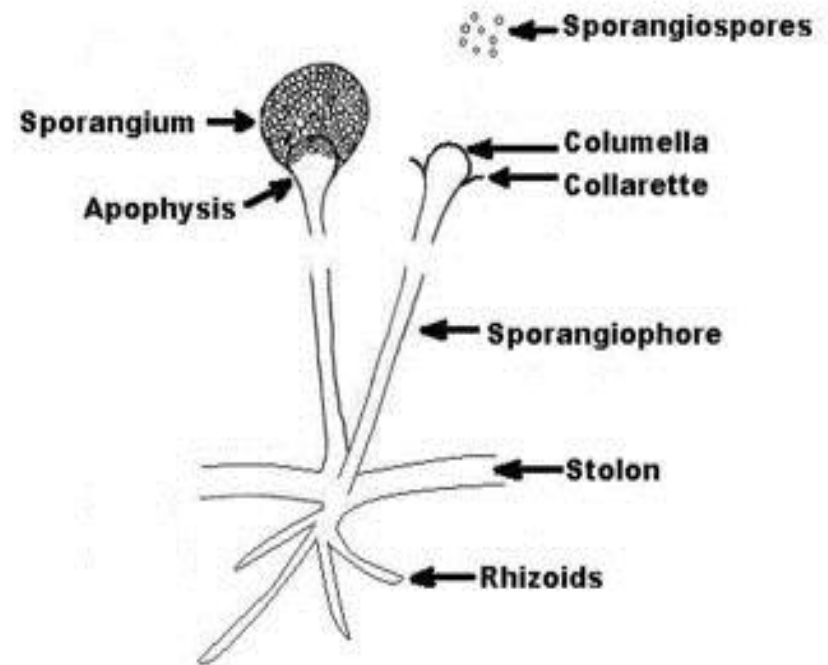
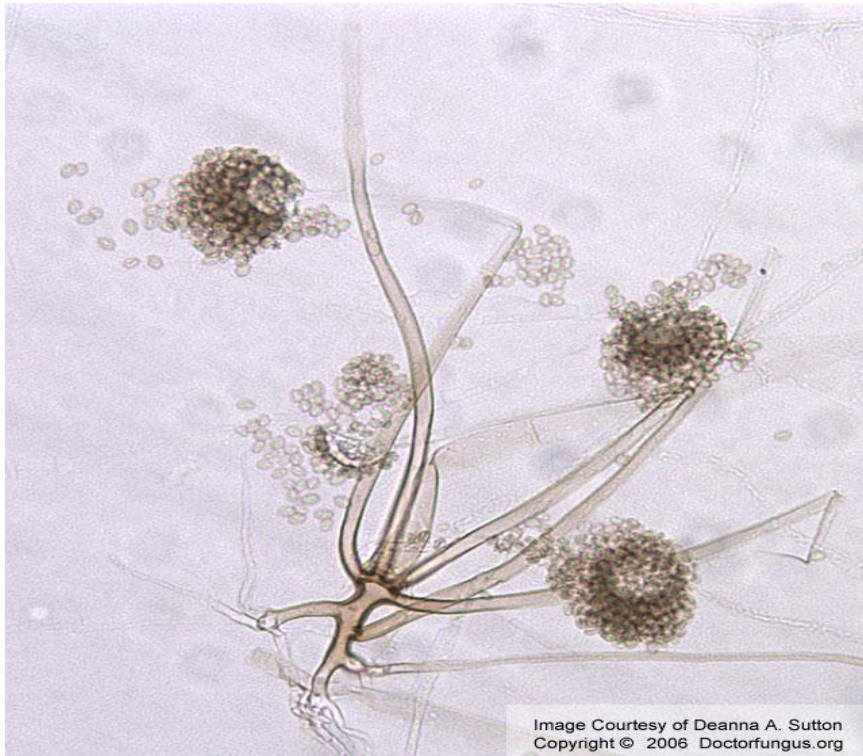
- 1- Hyphae are coenocytic structure.
- 2- Flagellated spores are absent.
- 3- Most reproduce asexually by producing sporangiospores within a special sac called the sporangium.
- 4- Sexual spores are called zygospores contained within a zygosporangium formed following gametangial fusion / copulation

Rhizopus stolonifer

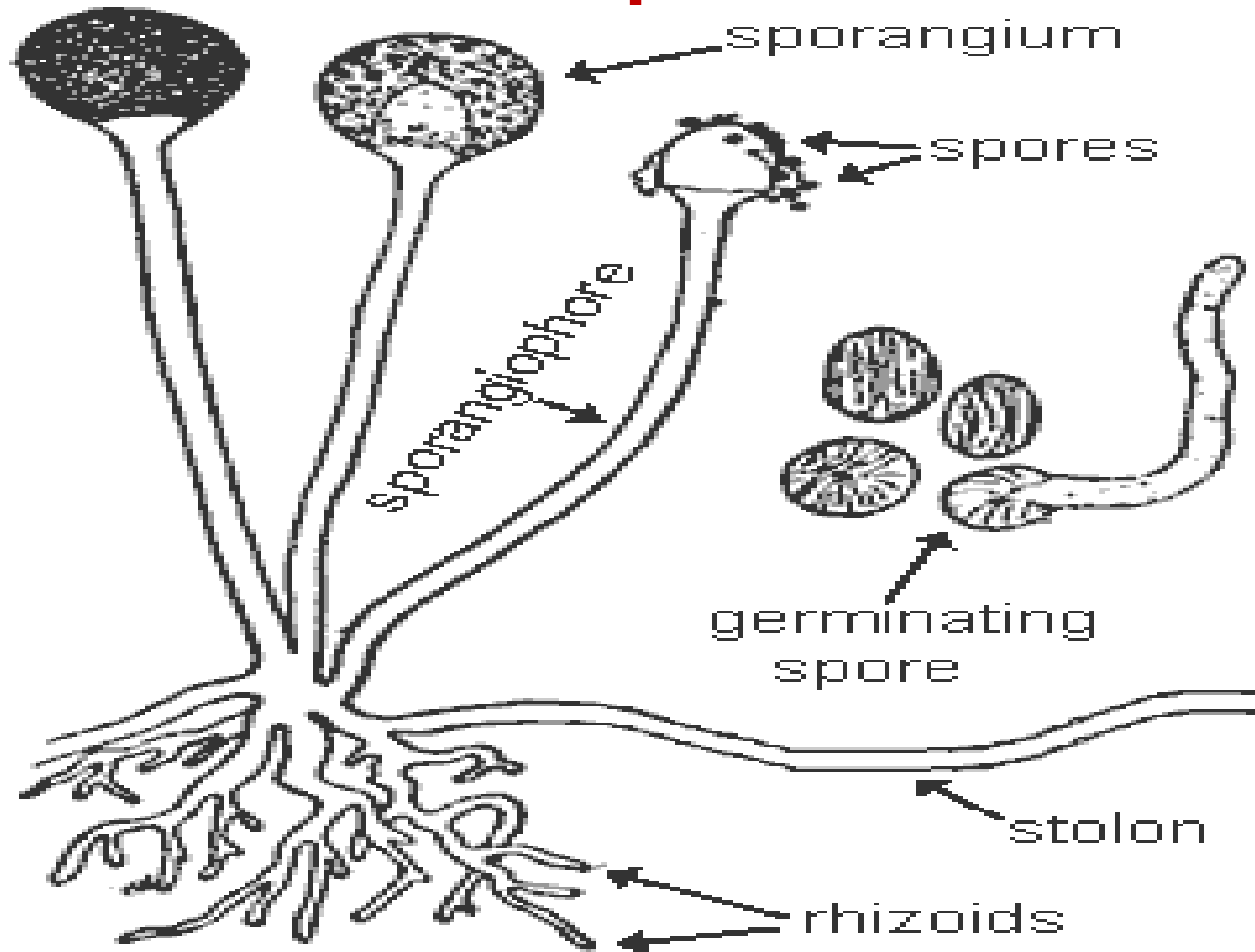
Structure:

Stolon, branched rhizoids, non-branched sporangiophore, sporangium, columella.

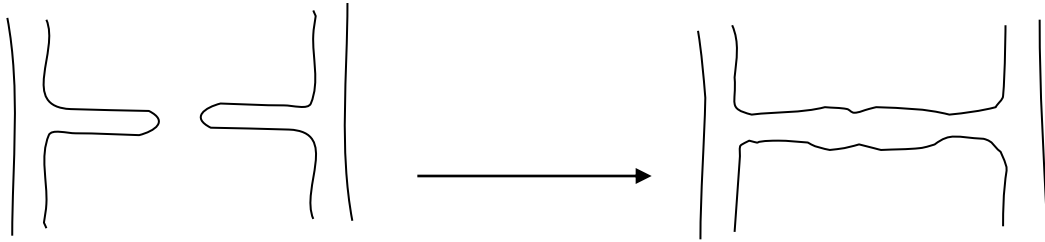
structure



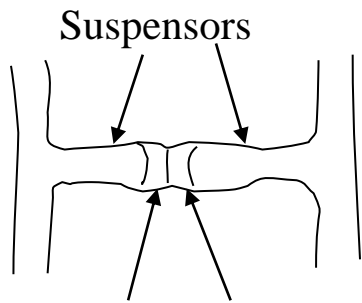
Asexual reproduction



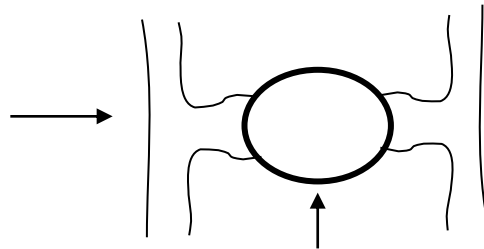
Sexual Reproduction



Progametangia

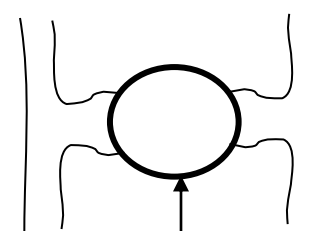


Gametangia

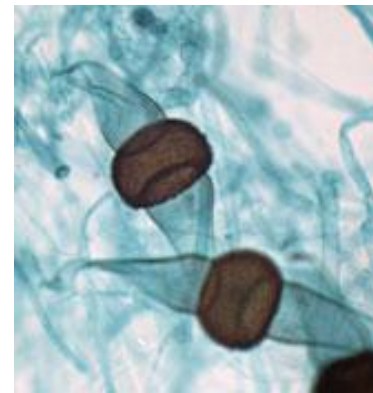


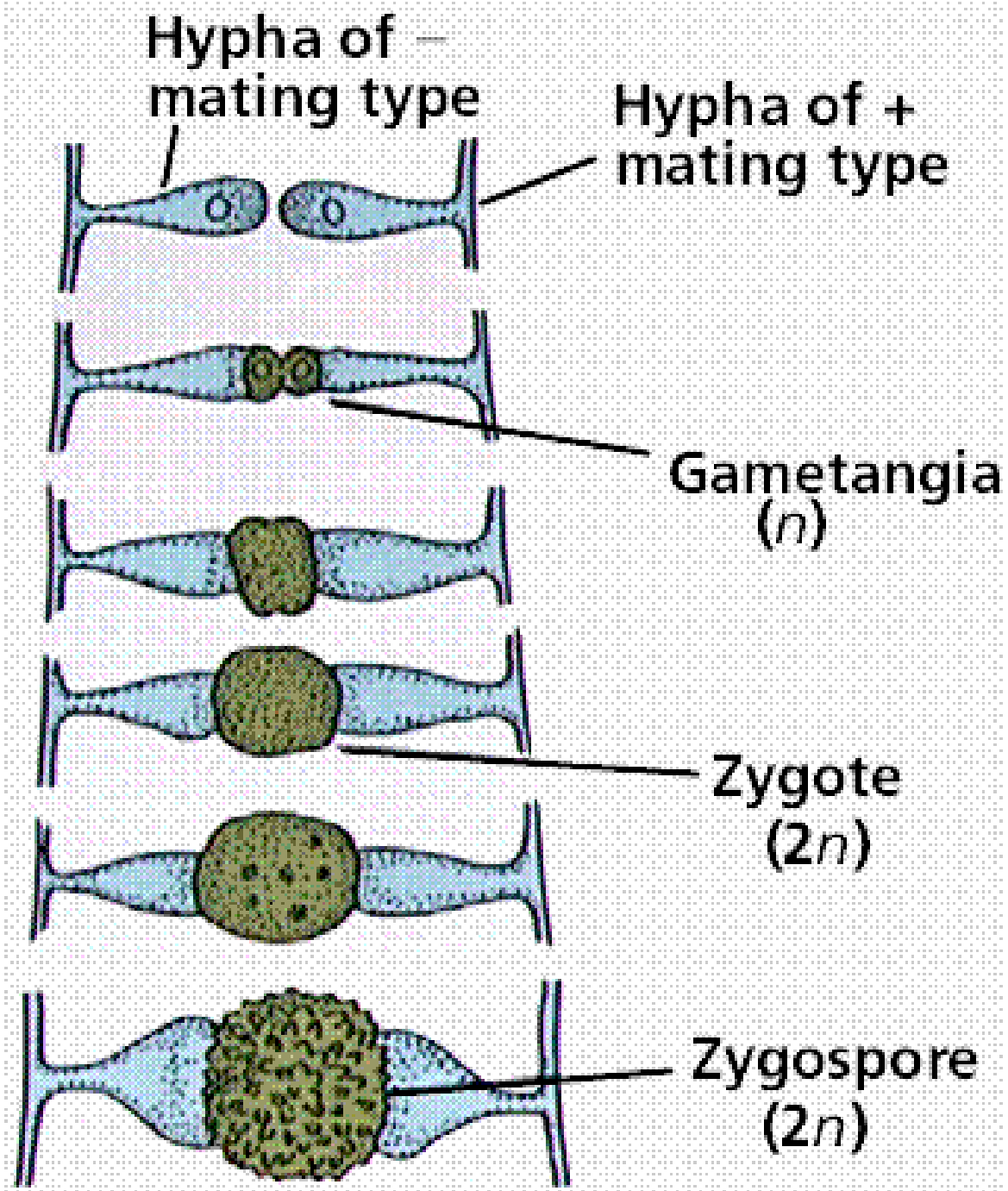
Zygote

karyogamy



Zygosporangium

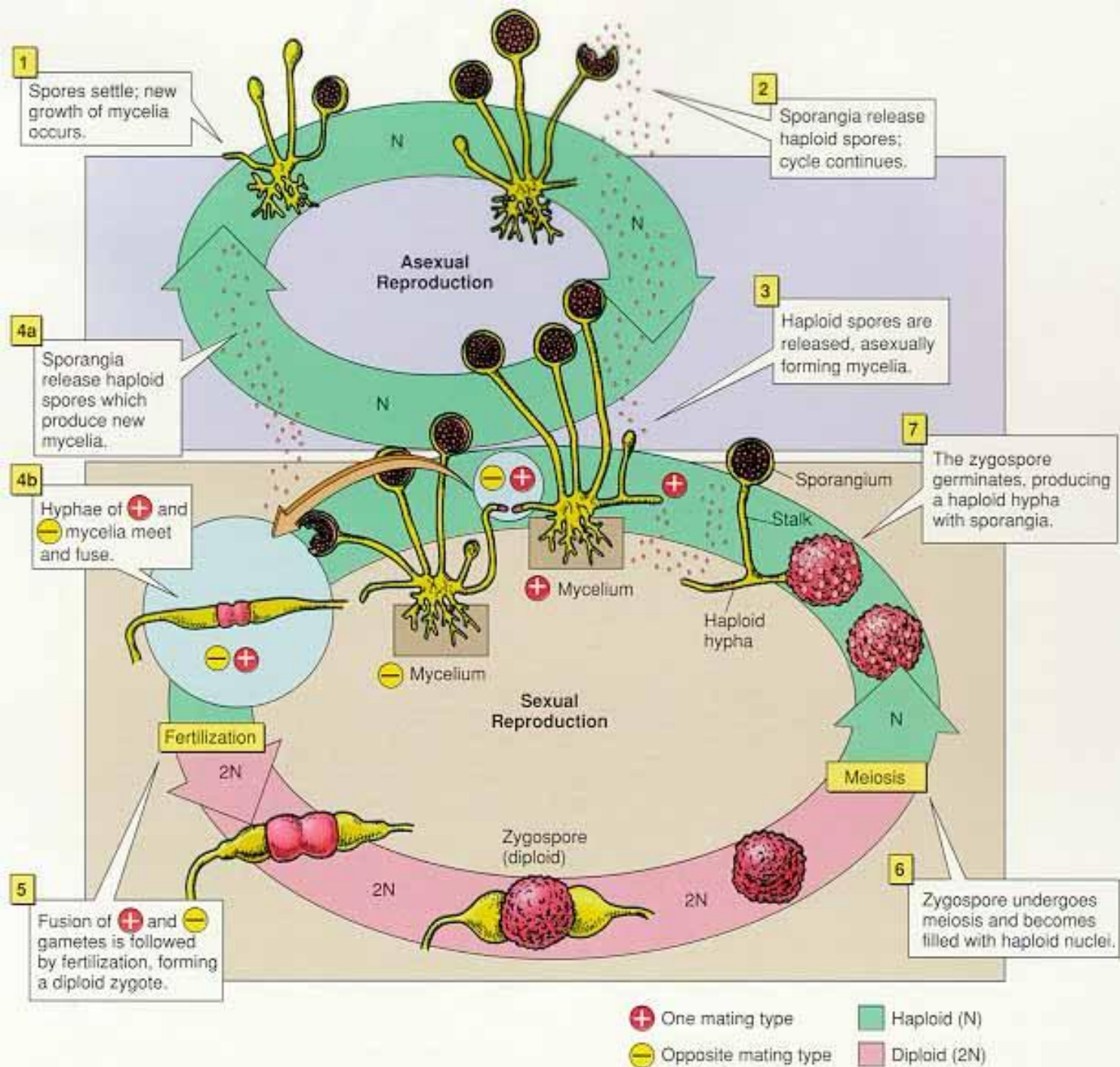






Rhizopus

Rhizopus





Rhizopus stolonifer

Systematic position:

Kingdom: Mycota

Sub-kingdom: Eumycota

Class: Zygomycetes

Order: Mucorales

Family: Mucoraceae

Genus: *Rhizopus*

species: *stolonifer*

3- Class: Ascomycetes

General characters:

- 1- The mycelium is septated. septated and branched except in yeasts (unicellular).**
- 2- They have ascospore borne inside ascus.**
- 3- Complete absence of flagellated cells.**
- 4- Cell wall contain large amount of chitin and less cellulose.**
- 5- May be parasites, causing several diseases to plant and human. Saprophytes which may produce useful enzymes and vitamins.**

6. Asexual reproduction by non motile conidia, which are produced on a specialized hyphae called conidiophore.

7. Sexual reproduction produce ascospores in ascus (sac like structure) usually 8 spores.

Ascocarp:

More than one ascus or even one may be enclosed in a fruiting body called **ascocarp** which may be :

Cleistothecium:

It is globose, which has no natural opening. The cleistothecium wall may not be covered with outgrowths (appendages).

The asci may be arranged in a hymenial layer or scattered.

Asci are liberated by disintegration of the cleistothecial wall.



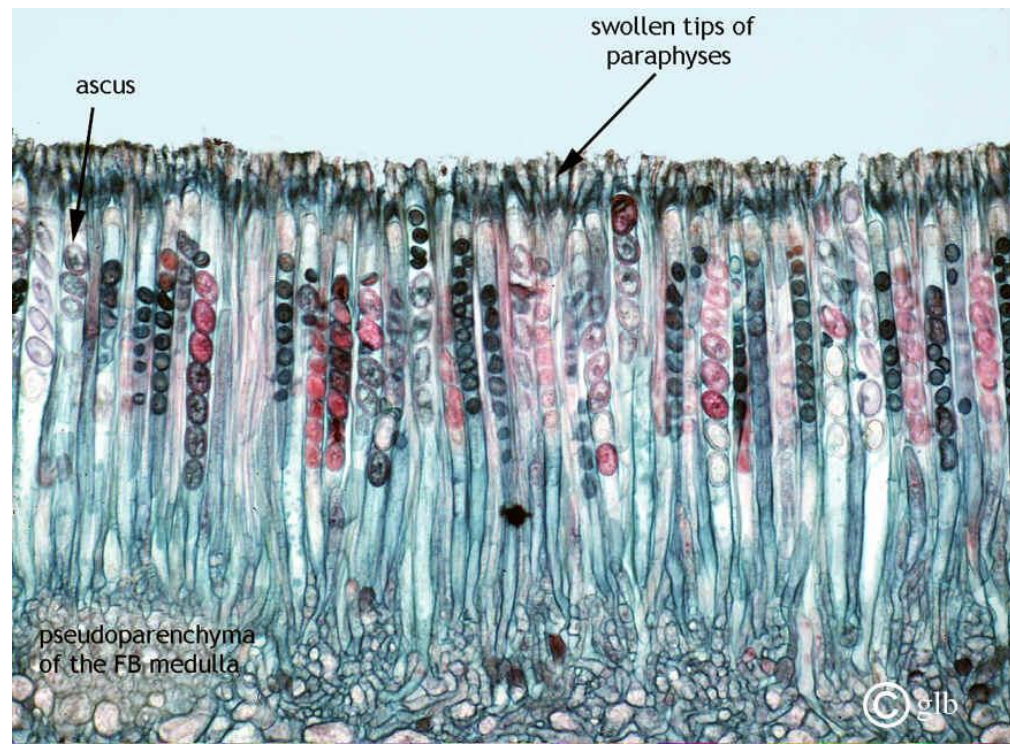
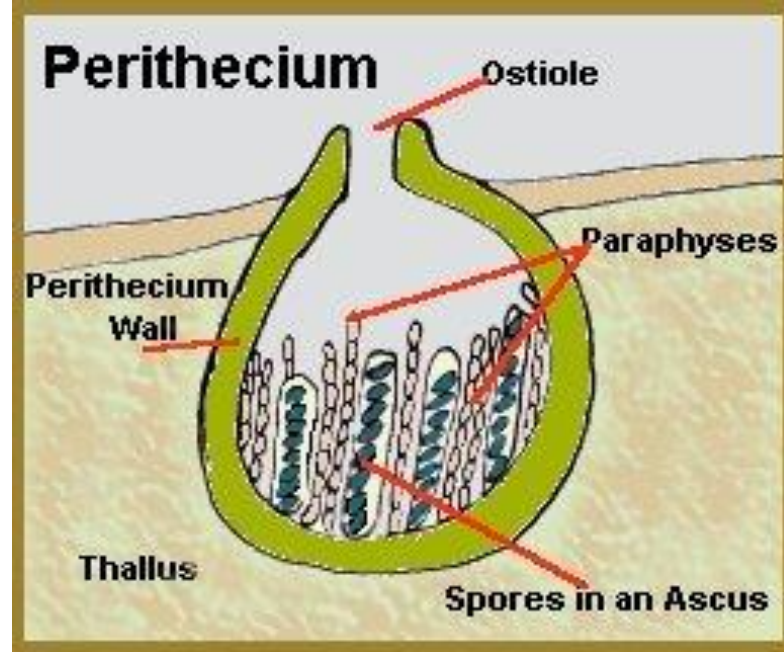
Perithecium:

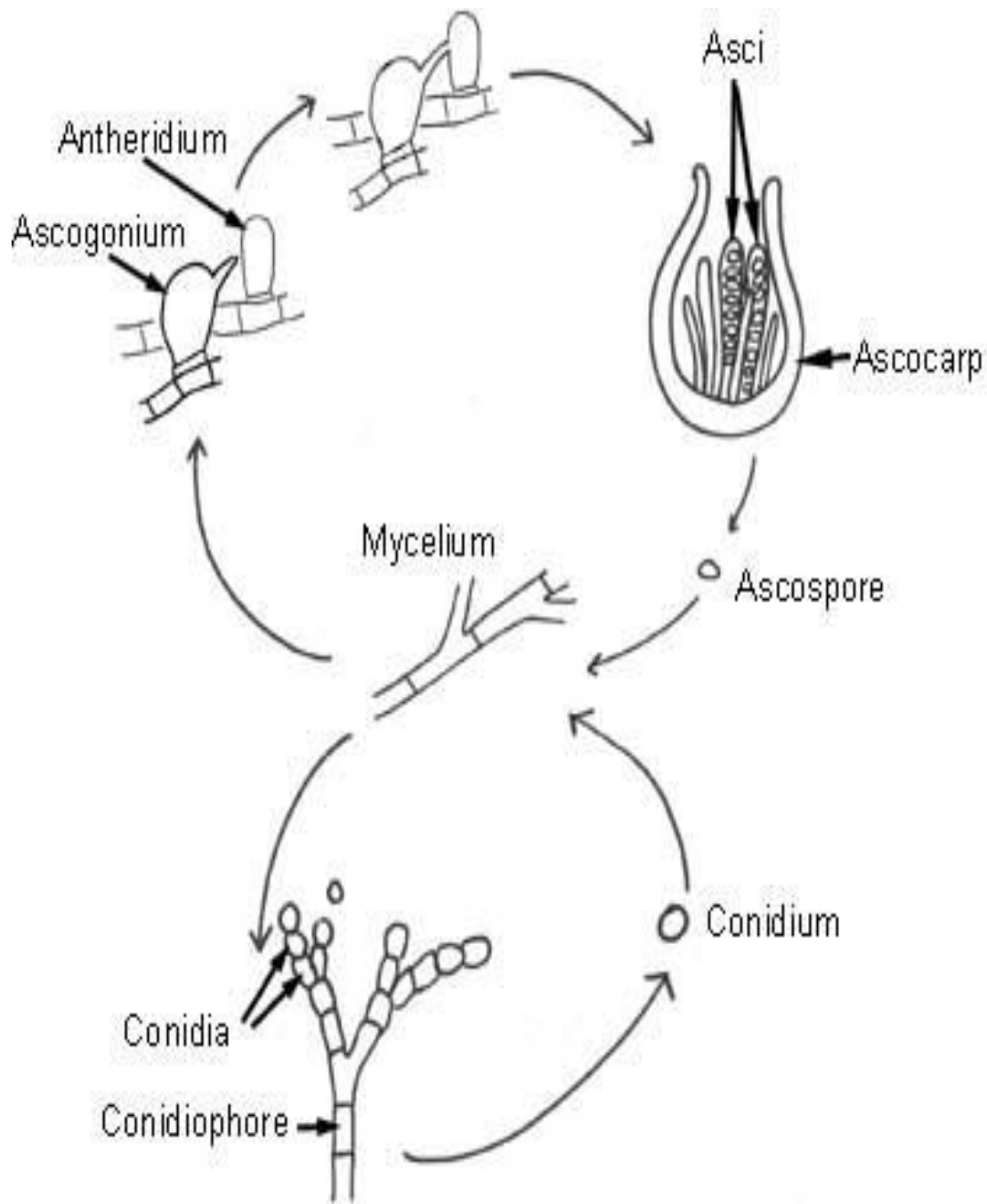
It is a flask shaped ascocar with an apical opening(ostiole).

The asci and paraphysis are arranged in a hymenial layer, ascospores liberated from the ostiole.

Apothecium:

It is a cup or saucer shaped ascocarp the asci and paraphysis are arranged on the upper surface in a hymenial layer

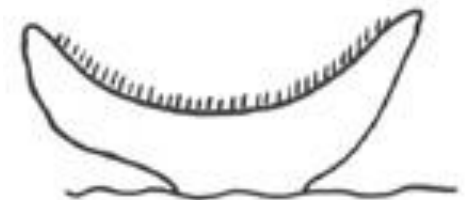




Cleistothecium

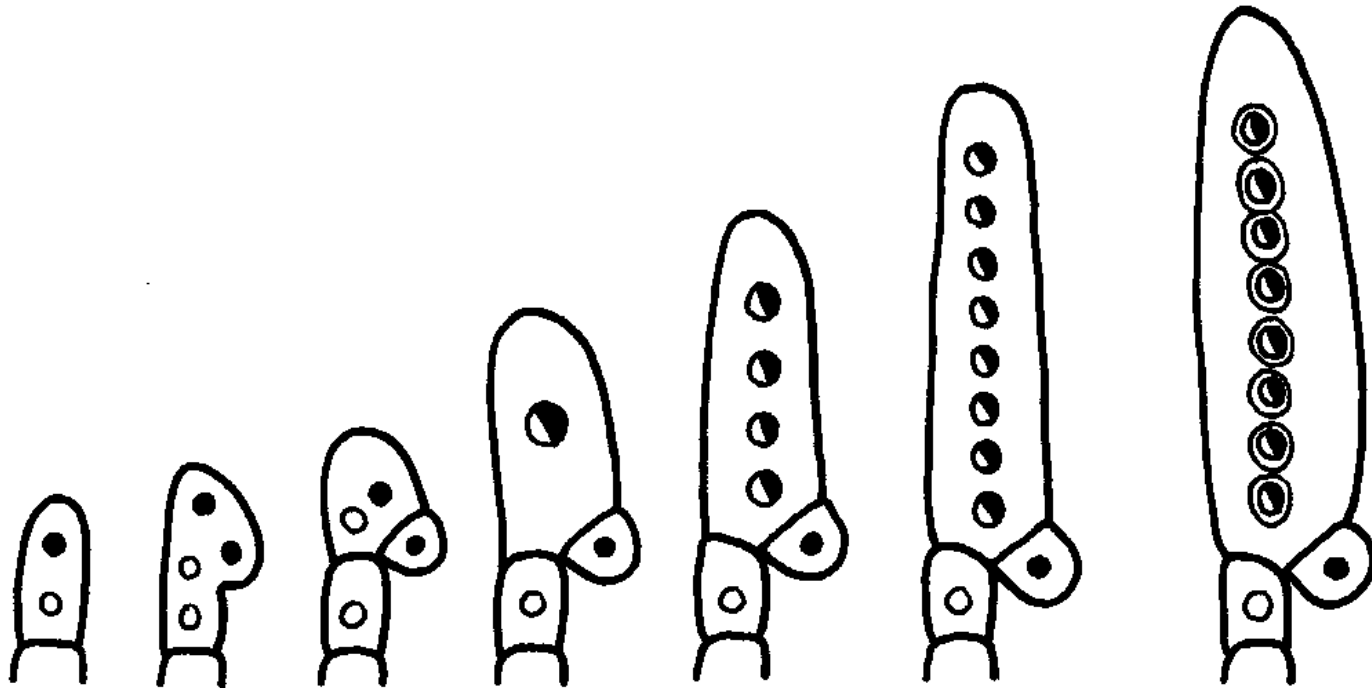


Perithecium



Apothecium

Ascus formation



Ascus



Subclass: protoascomycetes.

Order: Endomycetales.

Family: Saccharomycetaceae.

Saccharomyces cerevisiae.

- **Vegetative structure and economic importance:**

yeasts are unicellular organisms, oval or spherical shaped, live in colonies with white or yellow, and they are dimorphic.

➤ **Dimorphism:**

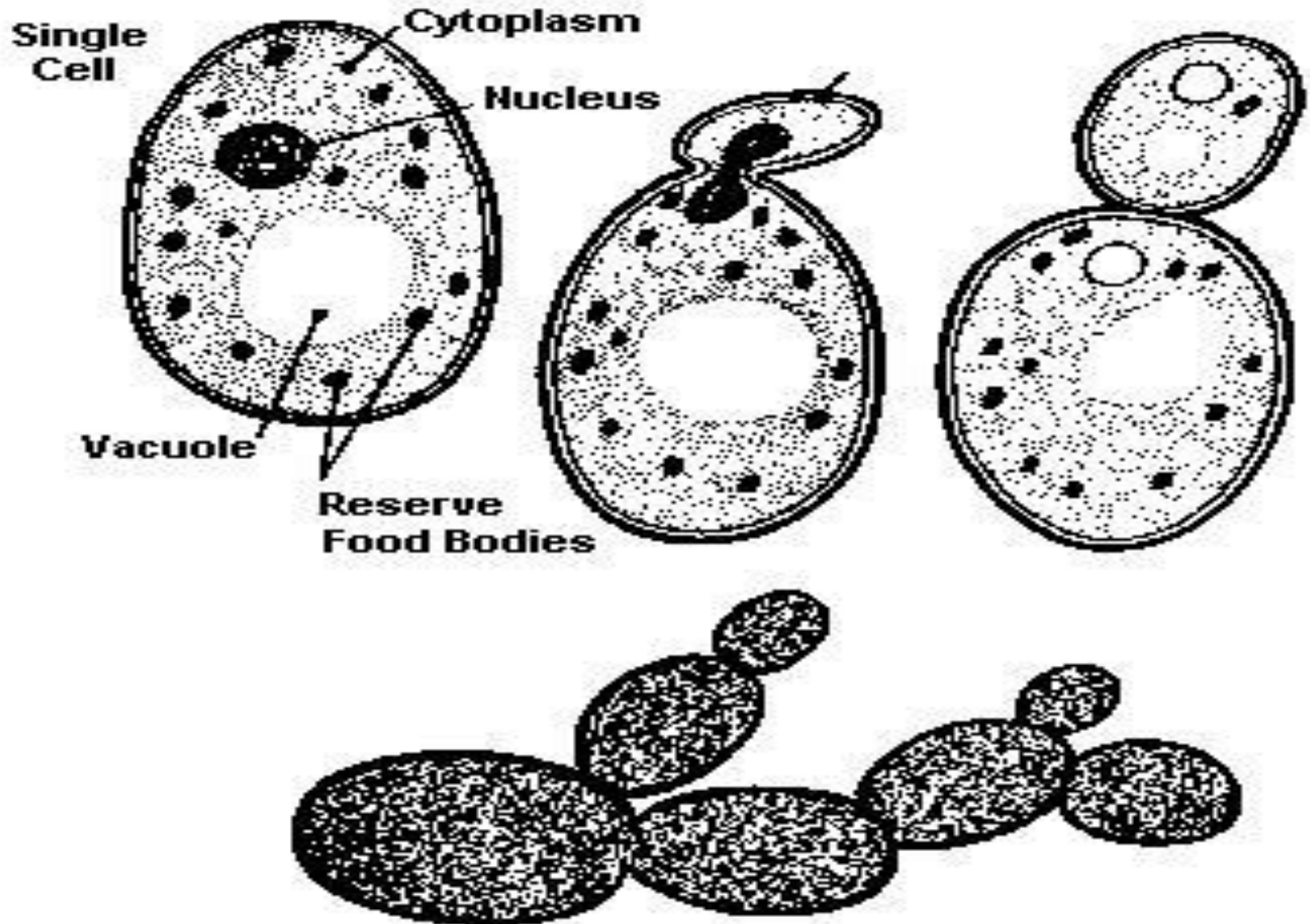
Is the ability of an organism to grow either unicellular or filamentous according to surrounding condition.

Ex:

Yeast at 37° c grow as unicellular.
 at 24° c grow as mycelia

- Saccharomyces has a very important role in industries such as fermentation, bread, vitamins, and alcohols production.

Structure of Yeast



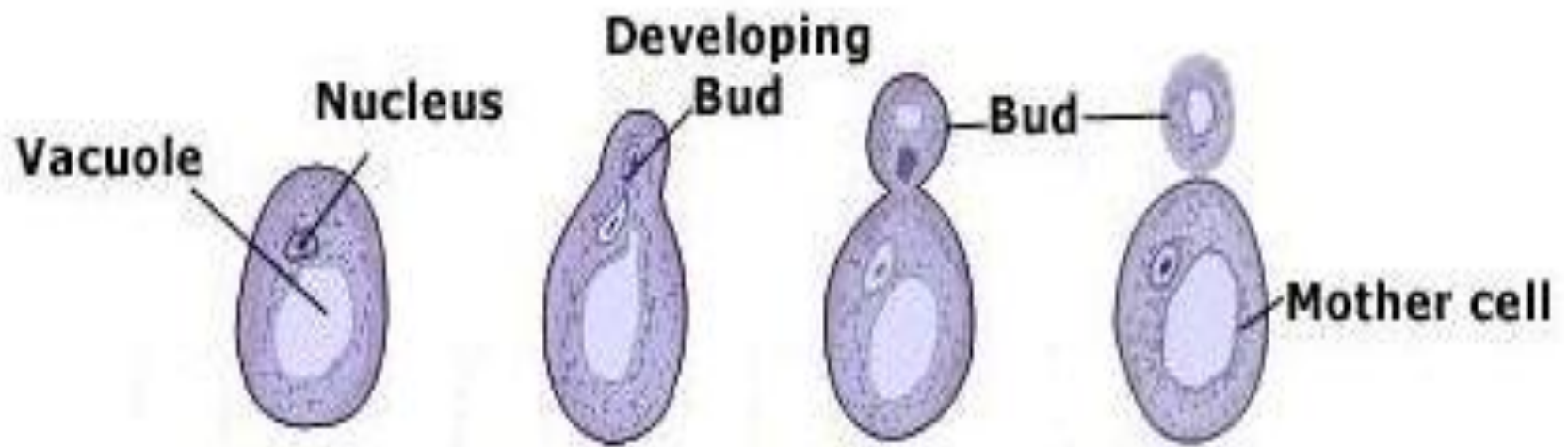
Reproduction of yeast:

1. budding:

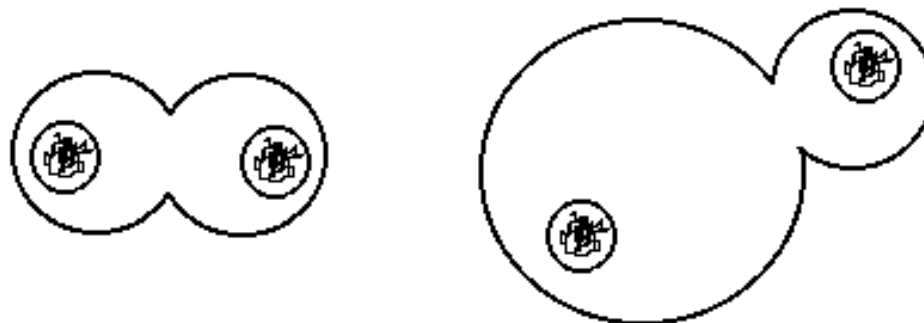
- At favorable conditions (food is abundant) the nucleus of the yeast cell divides mitotically and a bud is formed from the wall of mother cell.
- Then one nucleus passes into this bud with a part of the cytoplasm then this bud **separated** from the mother cell to give daughter cell.
- Some times the bud itself may give another bud and the bud do not detached from the mother cells resulting in the fromation of
- Achain of bud called **pseudomycelium**.

2- fission:

Parent cell elongates and its nucleus divides to produce two daughter nuclei , then a wall is formed in the middle of the cell to form two new cells.



Replicating Yeasts: Fission vs. Budding

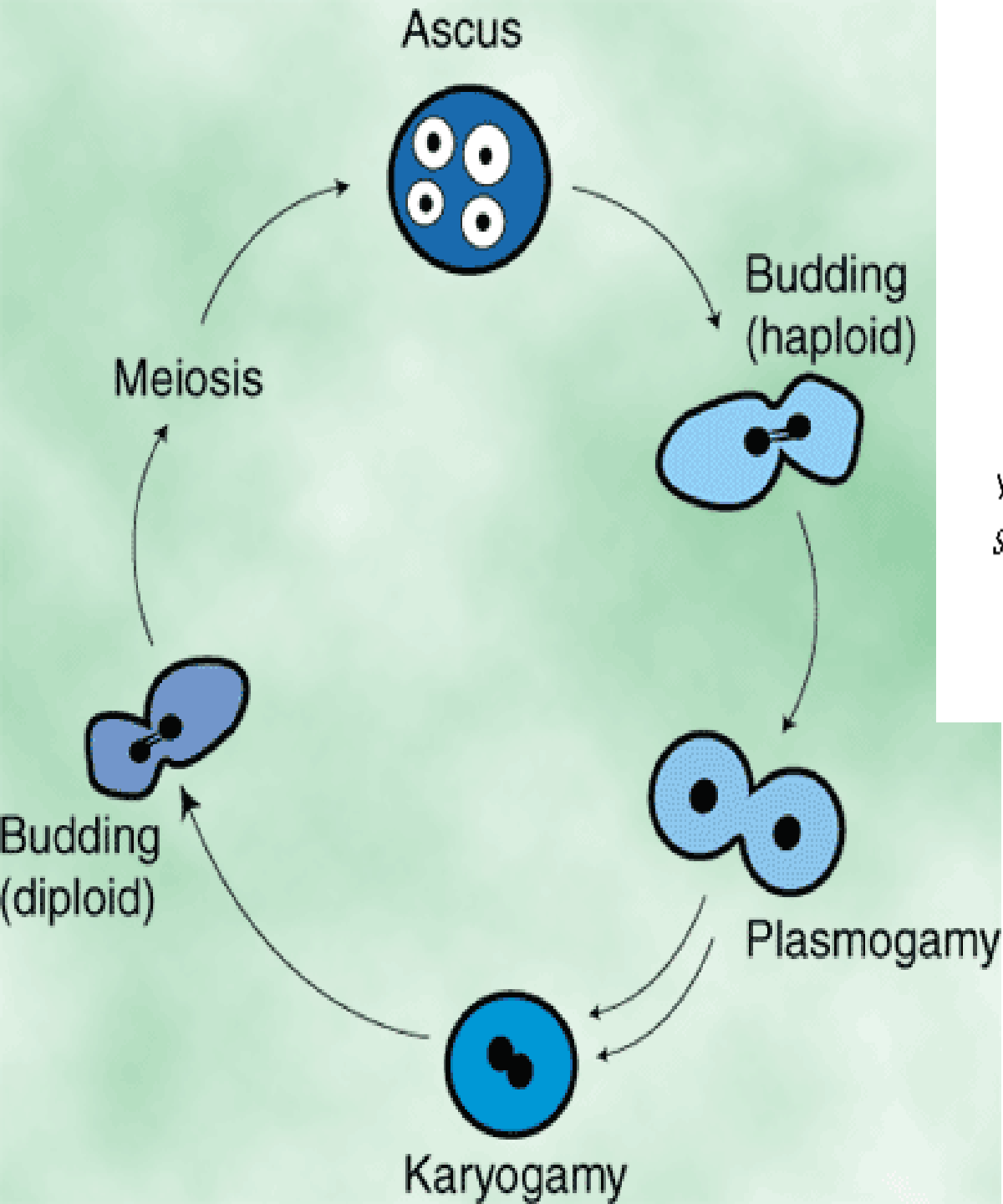


yeasts undergoing fission
Schizosaccharomyces spp.

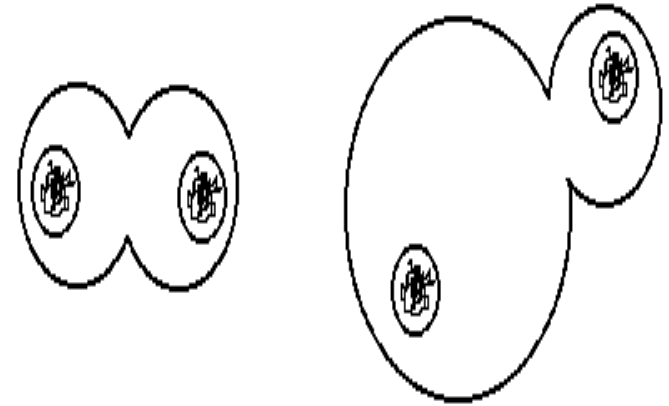
budding yeasts
Saccharomyces spp.



= nucleus containing DNA genome



Replicating Yeasts: Fission vs. Budding




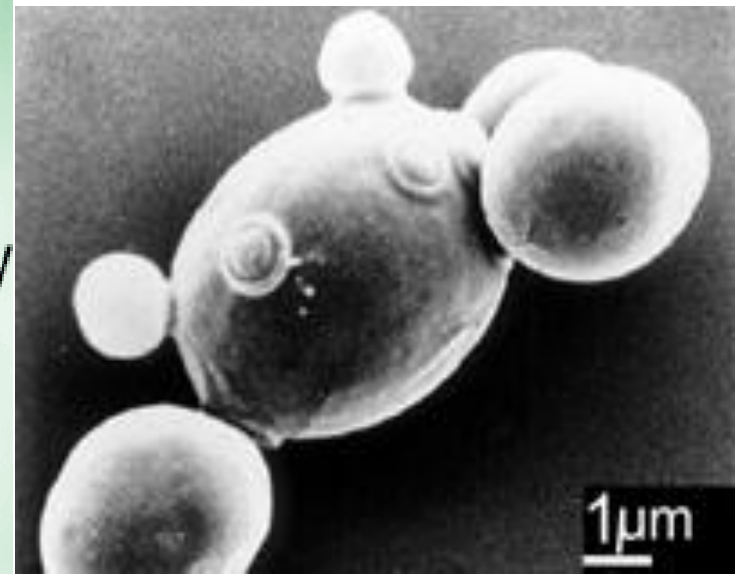
yeasts undergoing fission

Schizosaccharomyces spp.

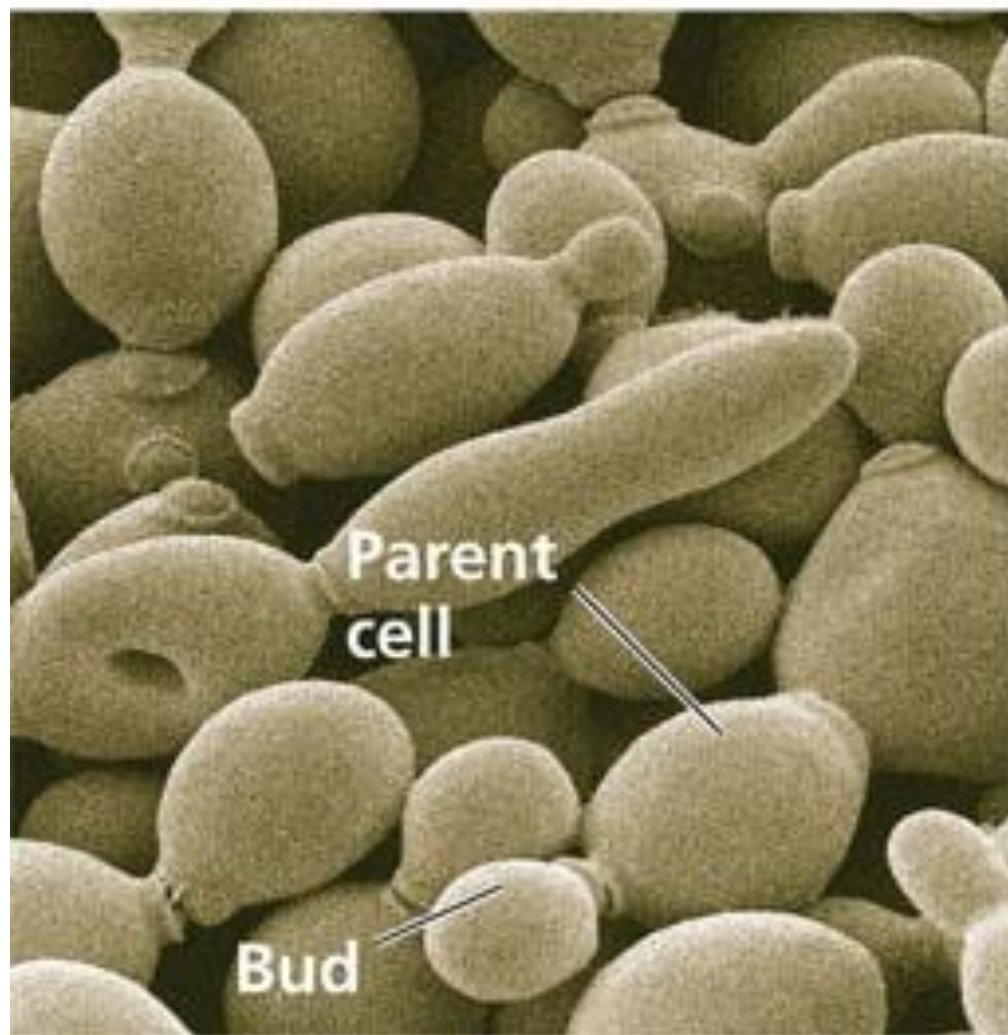
budding yeasts

Saccharomyces spp.

 = nucleus containing DNA genome



10 μm



sexual reproduction:

- It takes place when food is exhausted ,it occurs by conjugation between two vegetative cells the process is called hologamy ,this result in the formation of diploid zygote cell which function directly as an ascus and produce ascospores.
- 1-Haplontic life cycle. 2-diplobiontic life cycle.
3- haplodiplobiontic life cycle.

Kingdom: Mycota

Subkingdom: Eumycotina

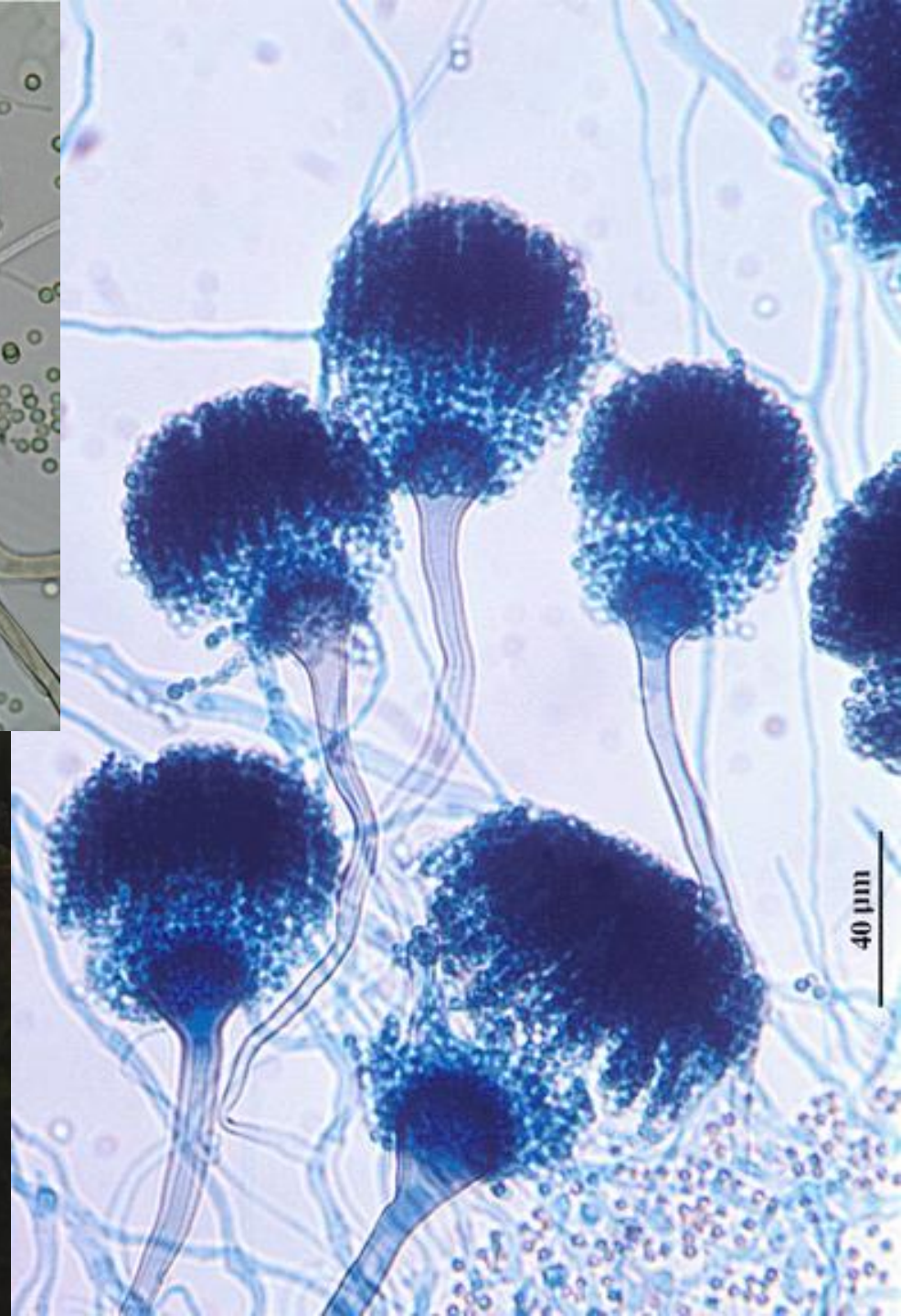
Phylum: Ascomycota

Class: Ascomycetes

Subclass: Euascomycotina

Aspergillus

- ***Aspergillus is a widely distributed genus, most are saprophytes on dead organic materials(fruits,jams ,leather, wood,.....) on orange, aspergillus form blue mould.**
- **On otherhand some species are parasites.**
- ****A.flavus*,*A.fumigtus* and *A.niger* cause diseases to human and animals known asperillooses also they may cause disease for human ear called otomycosis.**
- ***A. niger* is very important for industry. It produce about (18-19) enzymes including: cellulases xylanases amaylases pectinases,**



vegetative structure:

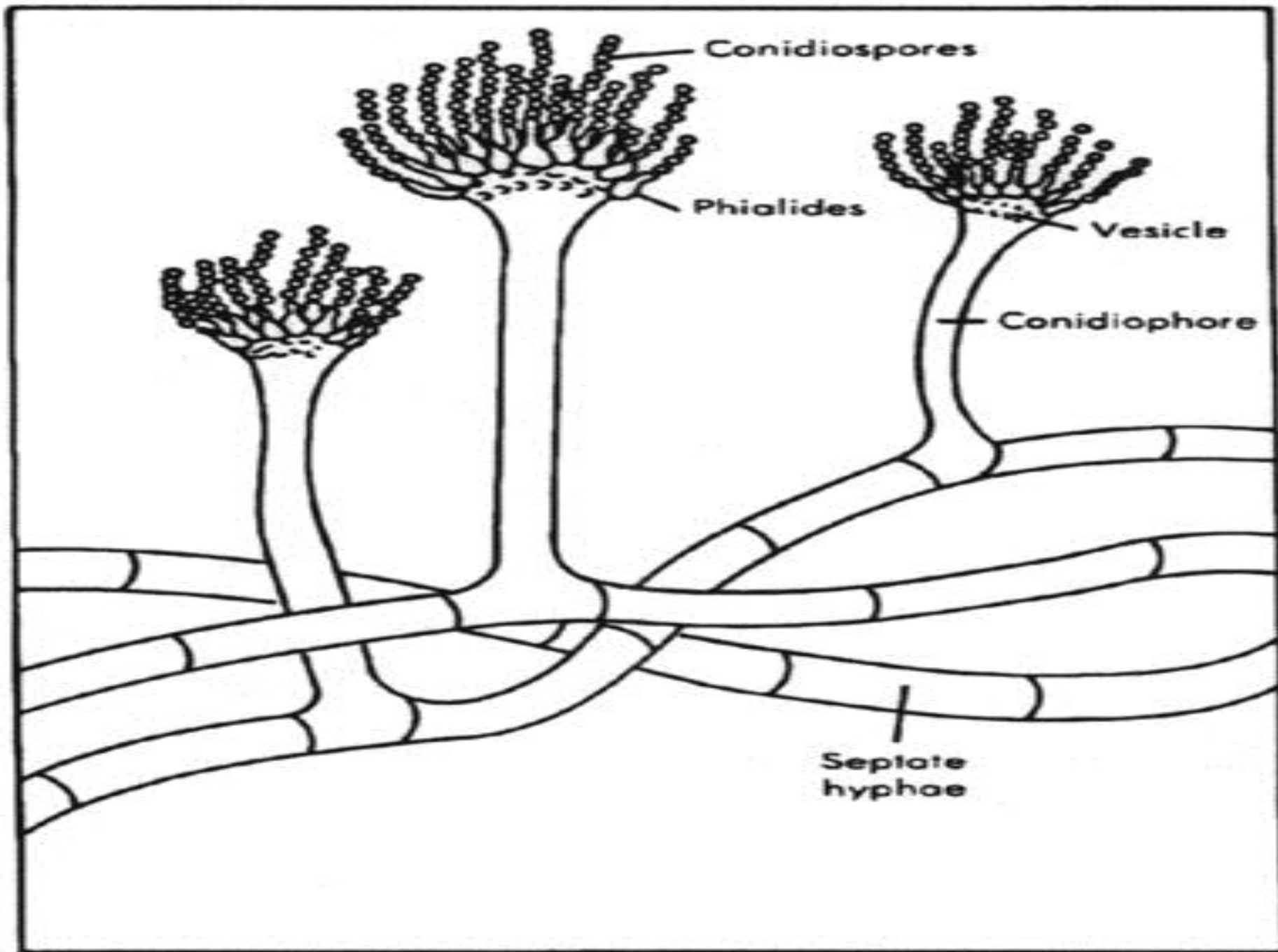
- The vegetative structure of *Aspergillus* is branched and septated mycelia which may:

Substrate mycelium:

Responsible for fixation and nutrient up take.

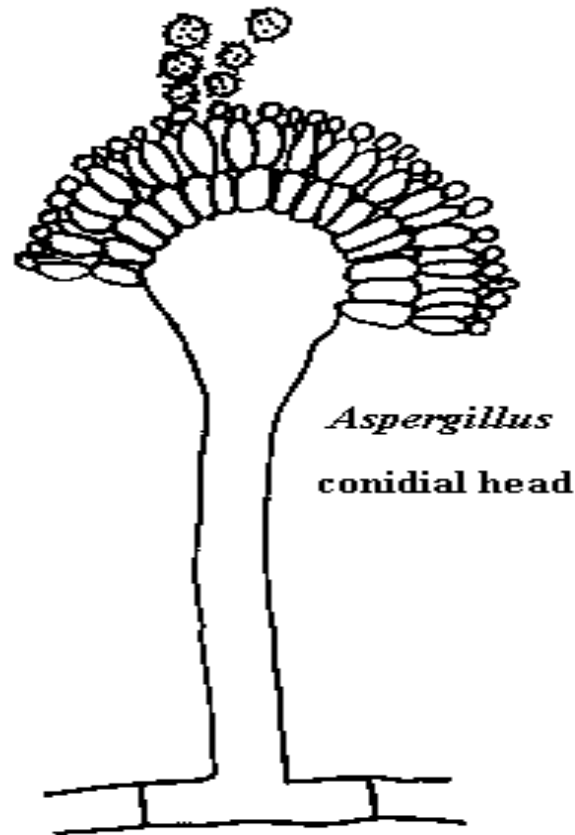
Aerial mycelium:

Appears above and carrying reproductive organs.

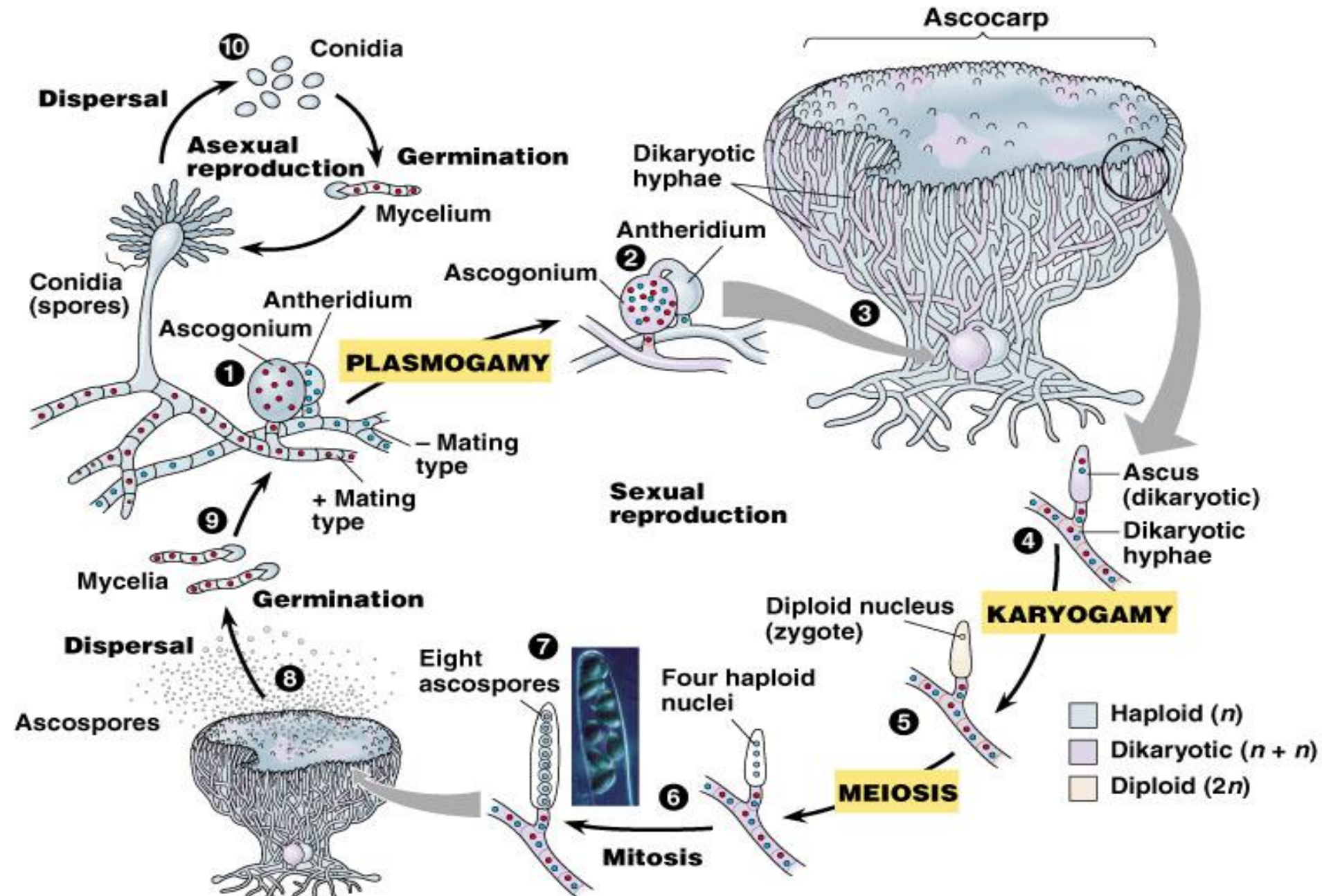


Asexual reproduction:

- It takes place by means of conidia ,which are formed in chains externally on conidiophores.



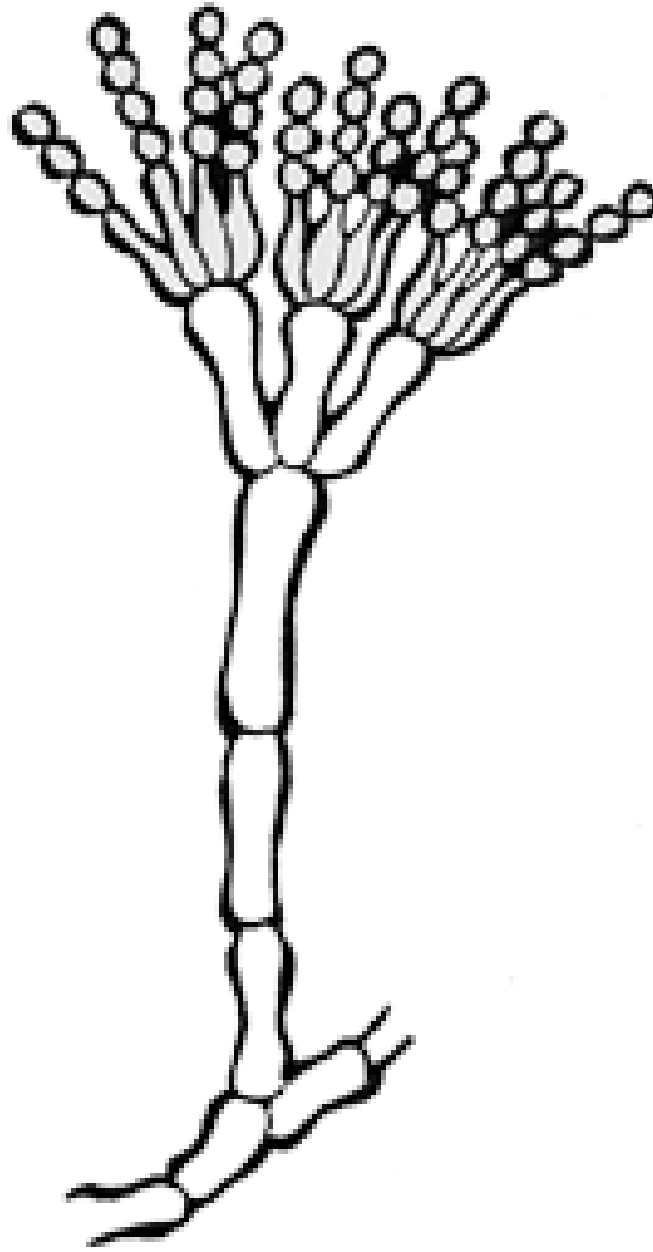
Sac Fungi: Ascomycetes - Life cycle



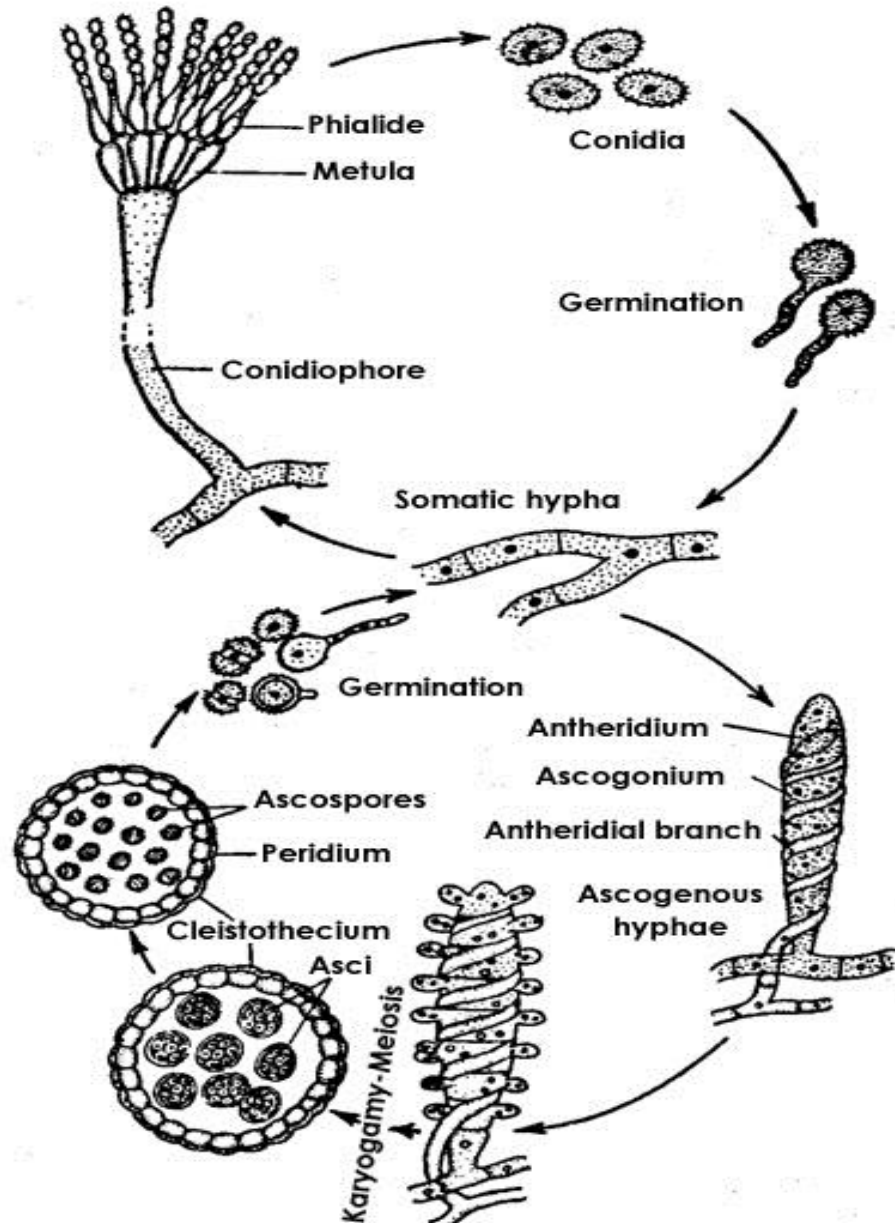
Penicillium

- *Penecillium* is a saprophytic fungus known as (blue or green mould), it lives on several organic substrates (fruits, vegetables, bread,).
- Vegetative mycelium is branched and septated.
- Some species such as *P. chrysogenum* produce the antibiotic penicillin (breaks bonds between peptidoglycan in the cell wall of G+ve bacteria).
- Conidiophores are septated and branched.

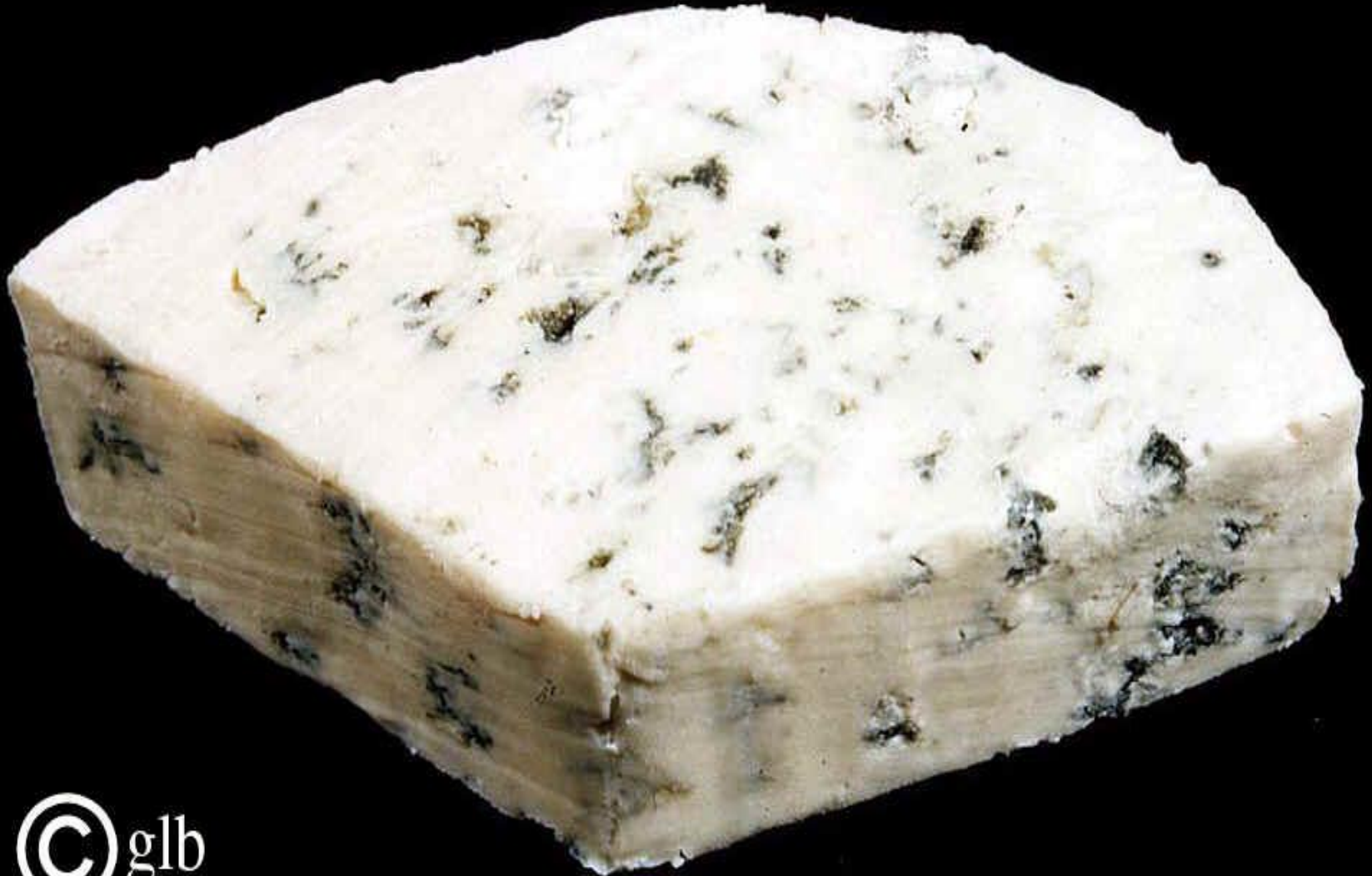
Structure of *Penicillium*



Life cycle of *Penicillium*



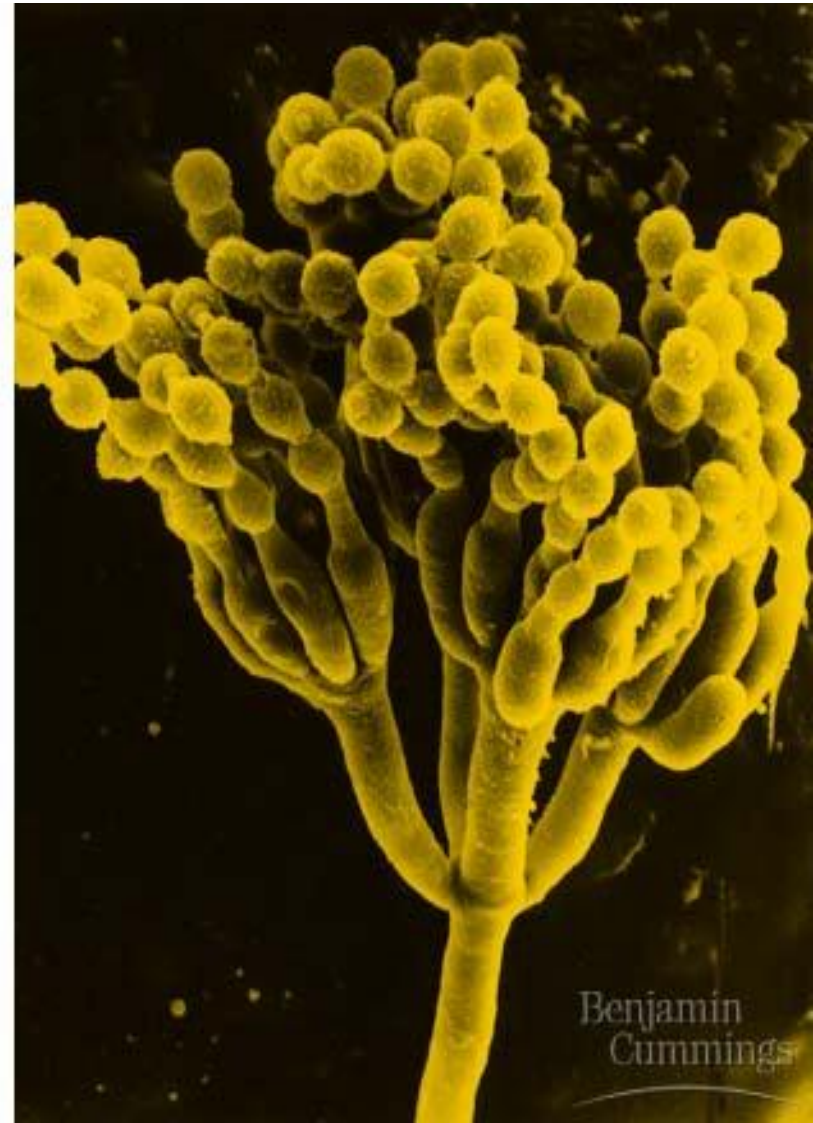
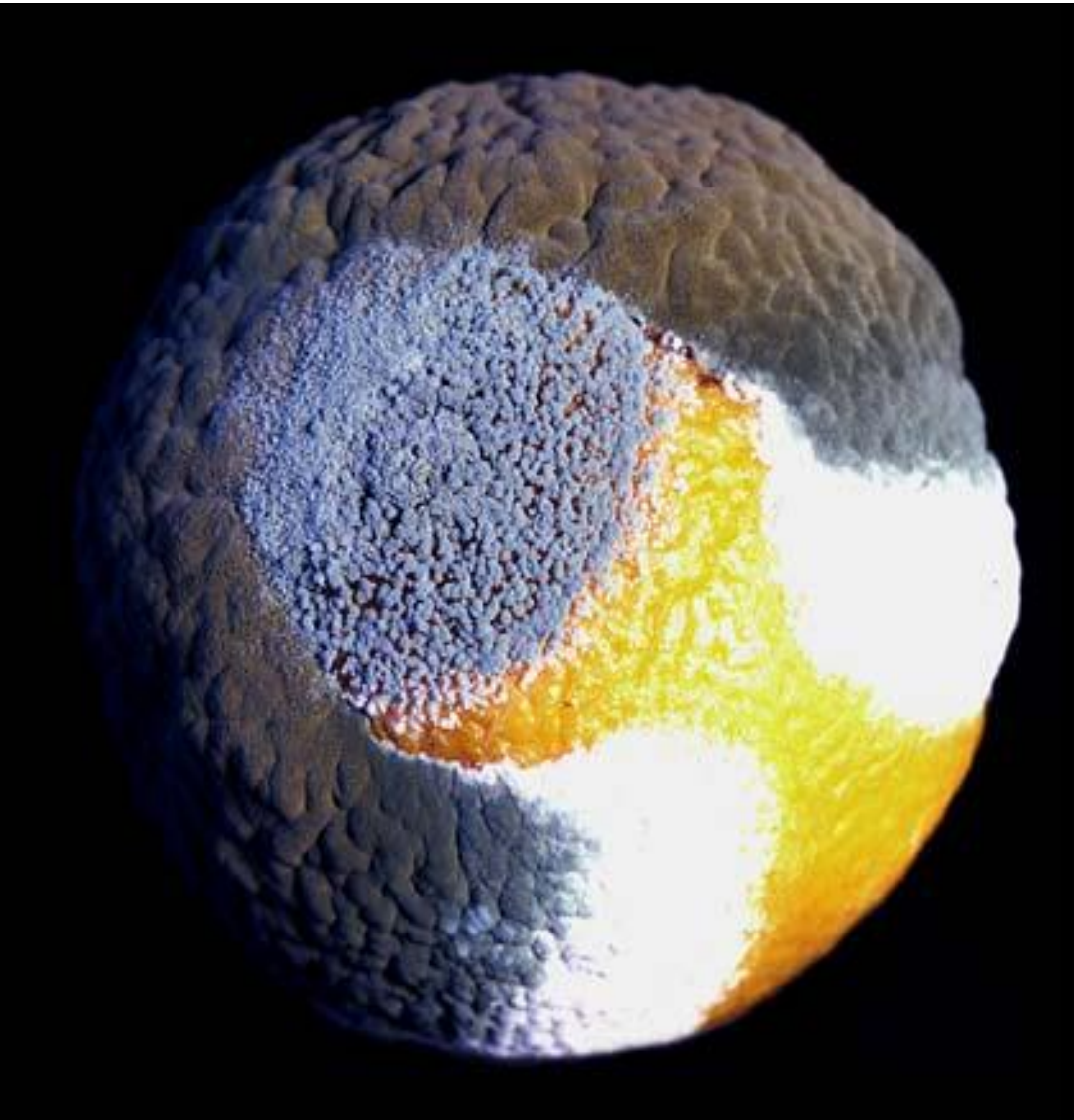
Rokfort cheese



Some human diseases caused by Ascomycetes

Disease	Causative organism	Sites involved
<u>Aspergillosis</u>	<i>Aspergillus sp.</i>	Sinuses, lungs
<u>Blastomycosis</u>	<i>Blastomyces dermatitidis</i>	Skin, lungs, bone
<u>Candidiasis</u>	<i>Candida sp.</i>	Eye, heart, lung
<u>Coccidioidomycosis</u>	<i>Coccidioides immitis</i>	Skin, lungs
<u>Histoplasmosis</u>	<i>Histoplasma capsulatum</i>	Skin, bone
<u>Paracoccidiomycosis</u>	<i>Paracoccidioides brasiliensis.</i>	Mouth, nose, skin, lungs
<u>Sporotrichosis</u>	<i>Sporothrix schenckii.</i>	Skin, joints, lungs

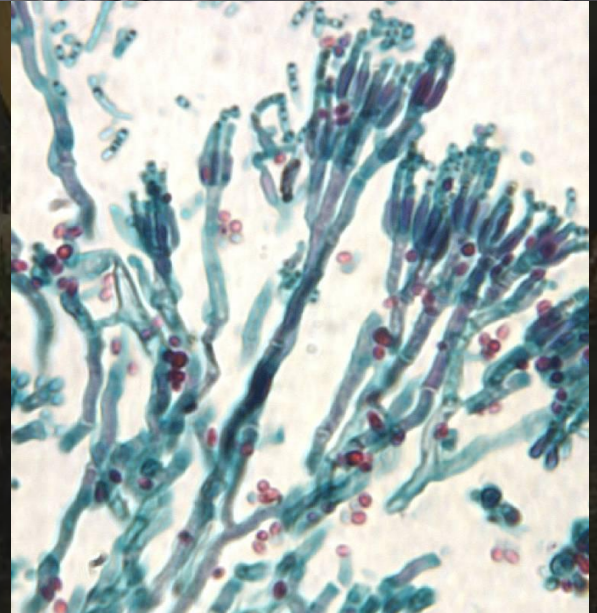
A moldy orange (left), *Penicillium* (right)



Penicillium sp.



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Green-Blue mold disease of citrus



4- Class: Basidiomycota.

- **General characters:**

1. The sexual reproduction produce basidiospores.
2. No flagellate cells are present.
3. Dikaryotic phase ^{long} dikaryotic mycelium. (may have clamp connection).
4. Presence of dolipore septum
5. (septated mycelium).

5. Basidiomycota:

parasites

rust fungi
smut fungi

Saprophytes.

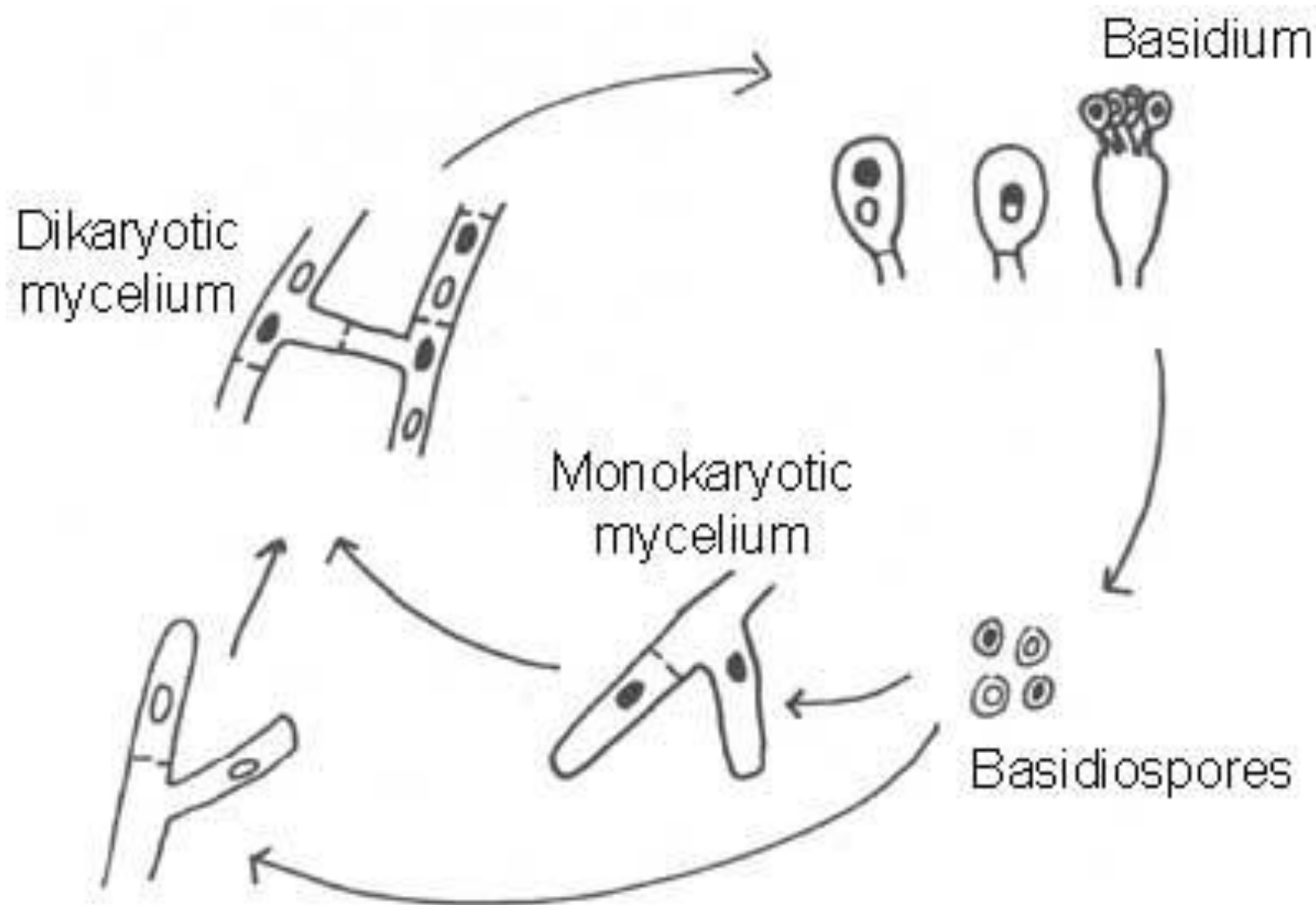
6. Cell wall contain high amount of chitin.

7. Forming macroscopic fruiting bodies.

8. Asexual reproduction by conidia, chlamydospores

Basidiomycota

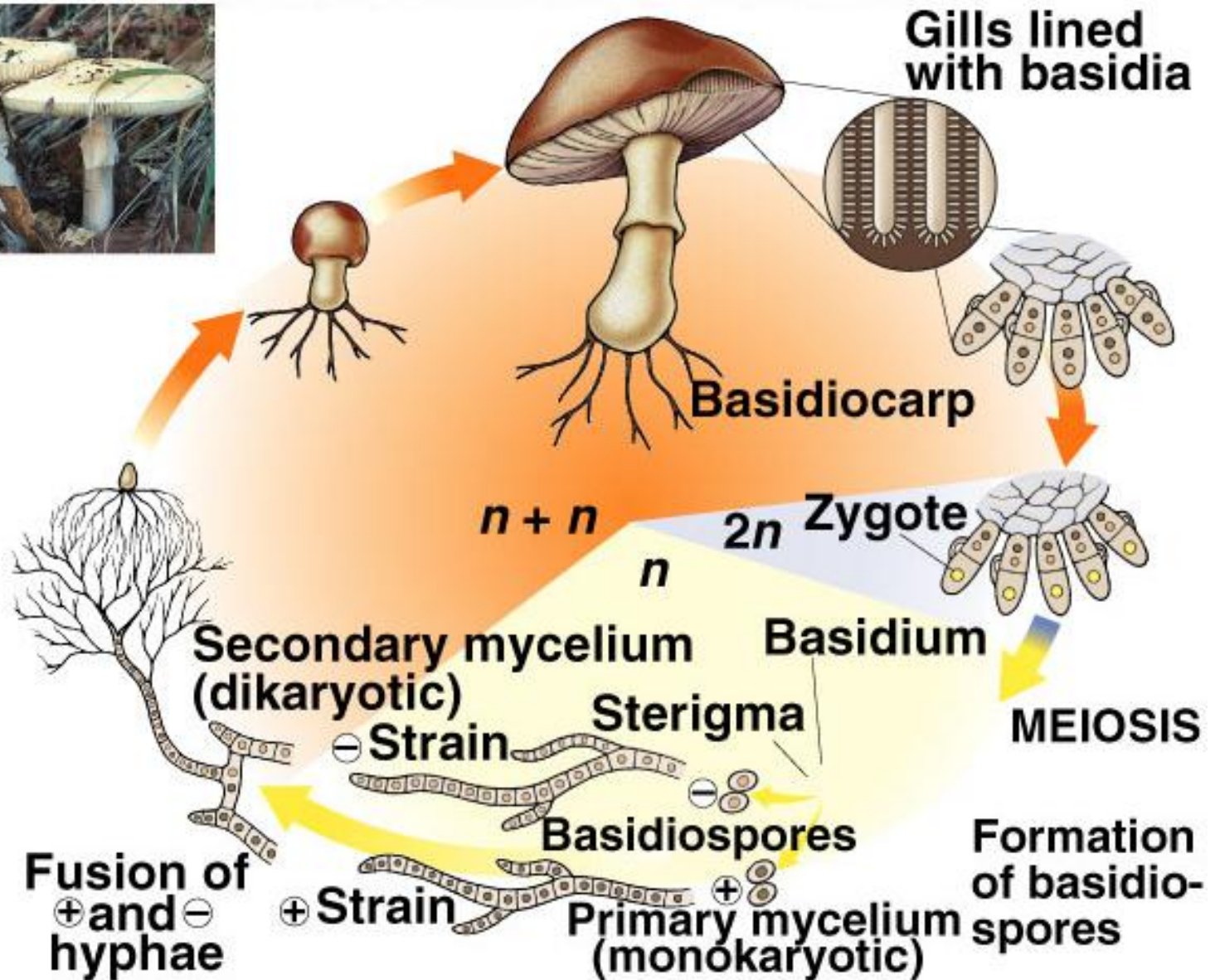
- Most familiar fungi (mushrooms, rusts, and smuts)
 - named for characteristic sexual reproductive structure, **basidium**
- Four haploid products of meiosis incorporated into **basidiospores**
- Mycelium made up of monokaryotic hyphae is called **primary mycelium**.
 - fusion of different mating types forms dikaryotic, **secondary mycelium**.



Basidiomycota



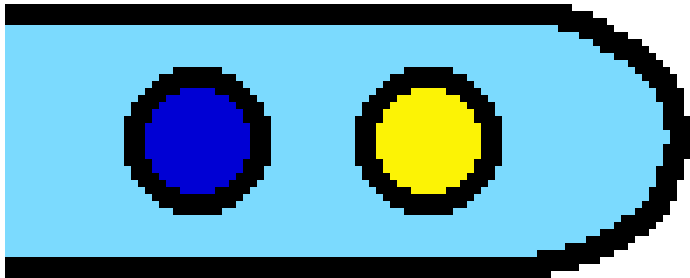
(a)



(b)

- **The clamp connection:**

Found in all dikaryotic mycelia of basidiomycota
except for most uredinomyces



Agaricus sp.



Agaricus is a large and important genus.

Containing both **edible** and **poisonous** species.

Agaricus fruiting body consists from: *stipe*, *pileus*, gills, spores., annulus.

Reproduction of *Agaricus*

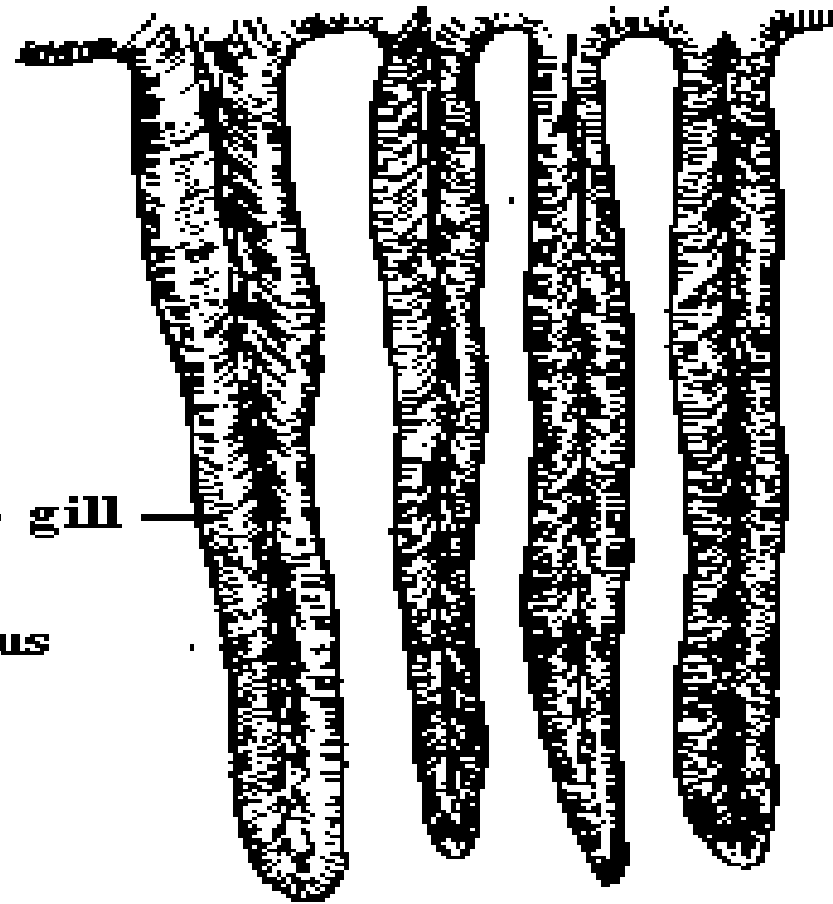
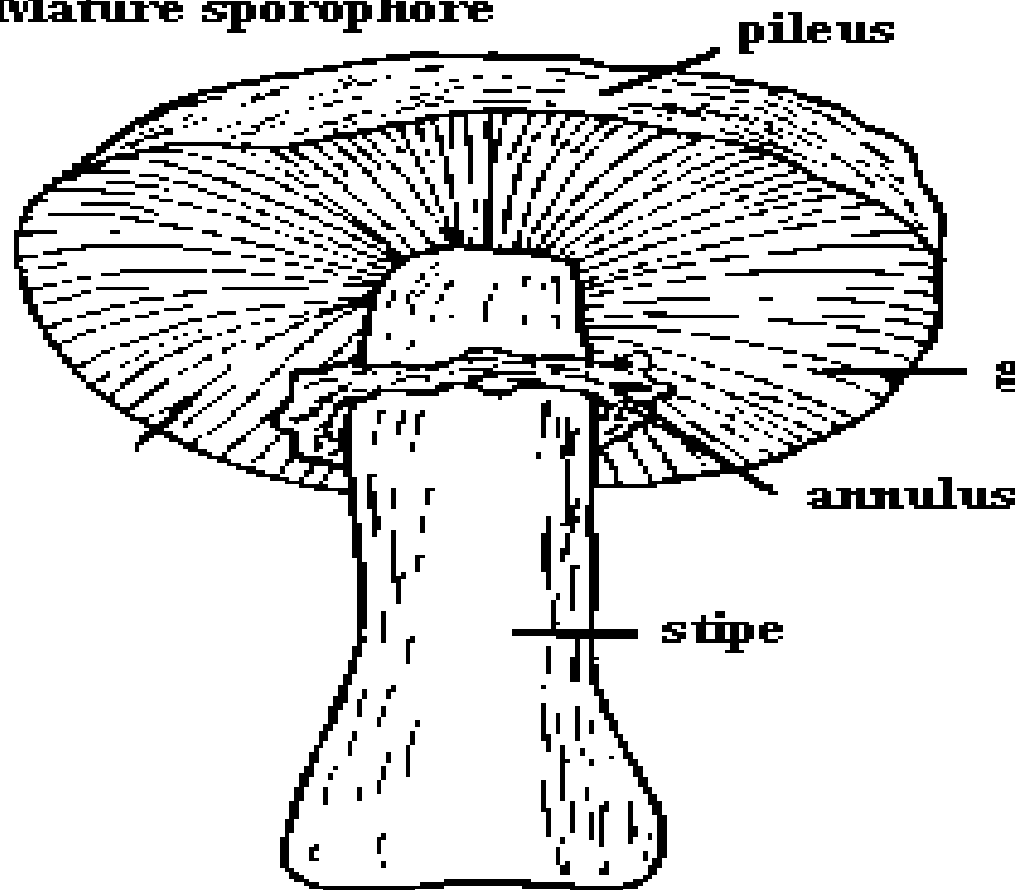
- asexual

- sexual

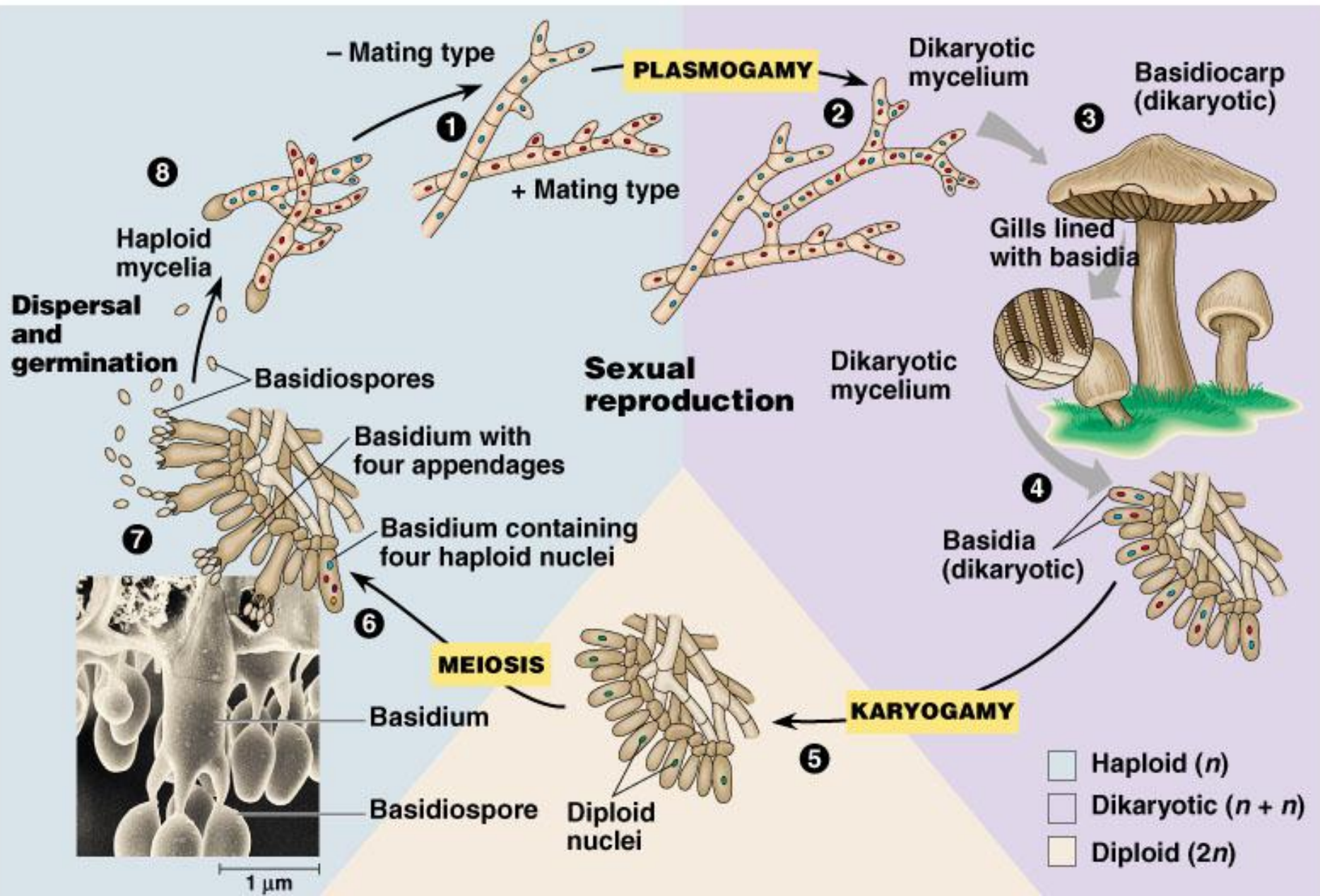
Mushroom

Agaricus campestris

Mature sporophore



The life cycle of a mushroom-forming basidiomycete



• *Puccinia graminis*

- Parasitic on Wheat and berberis plants.

- On wheat: form:

uredial stage

uredospores

teletial stage

teleutospores

- In soil: form basidial stage

basidiospores

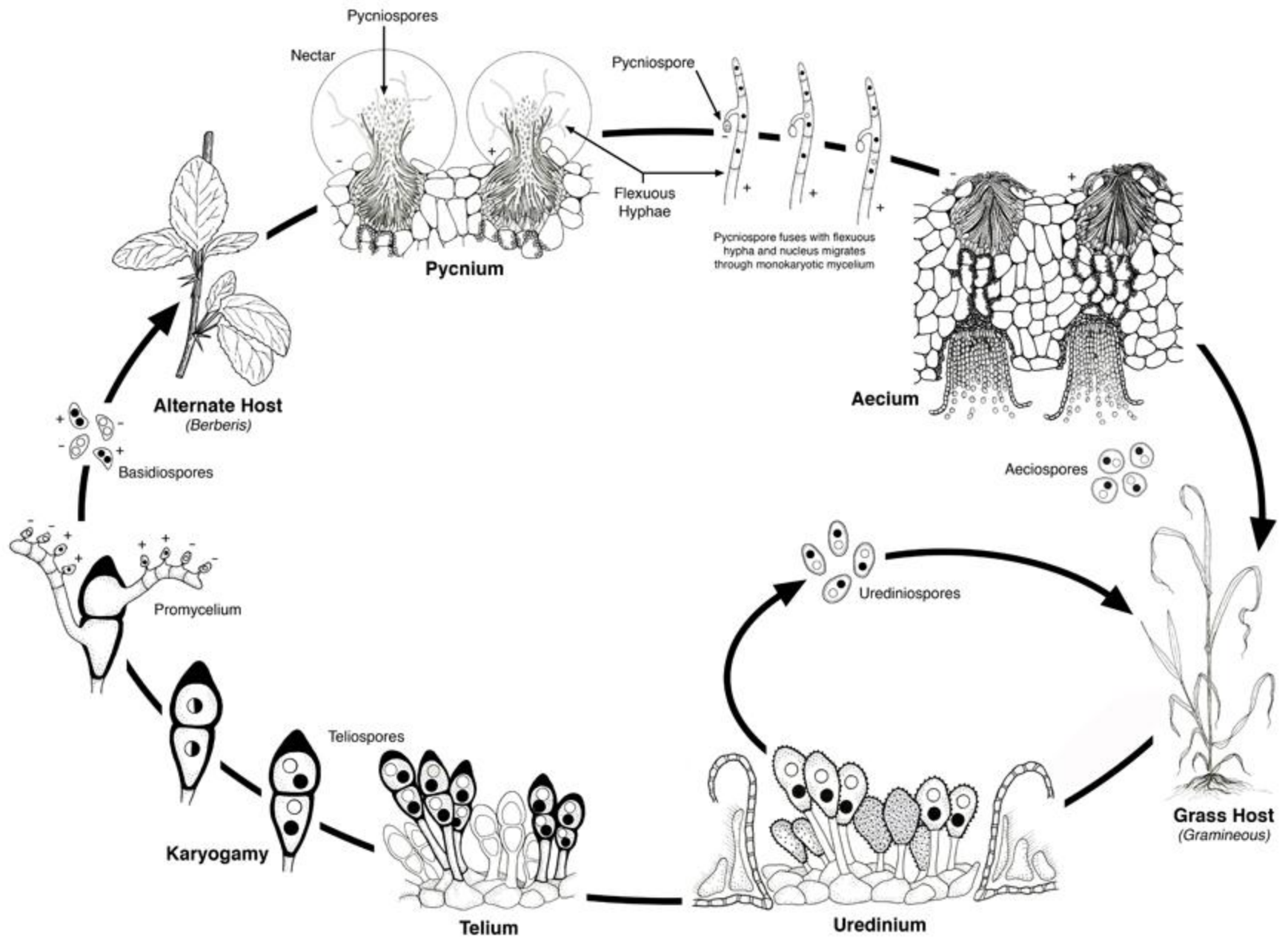
- On berberis leaf form:

pycnidial stage

pycniospores

acedial stage

acediospores





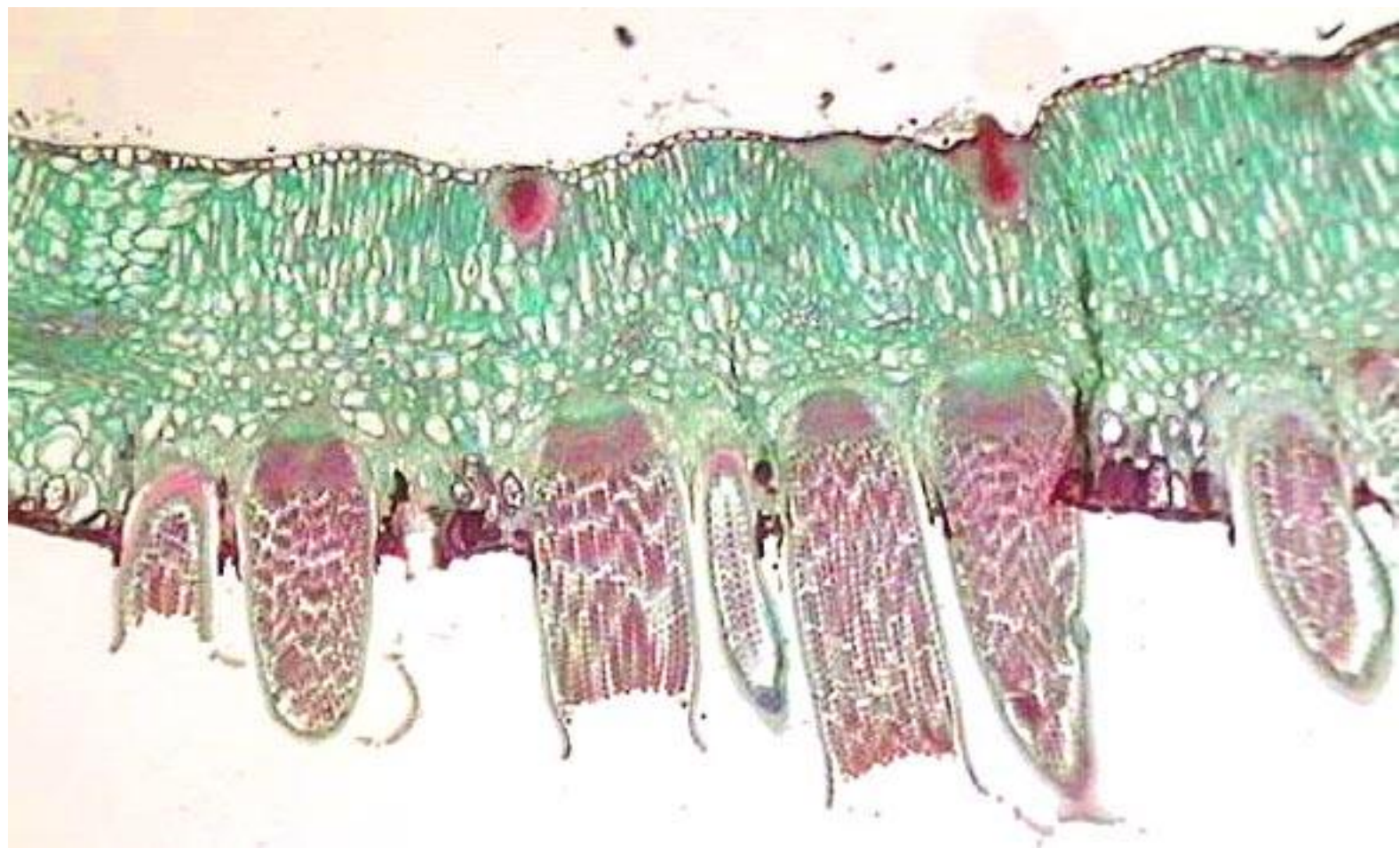


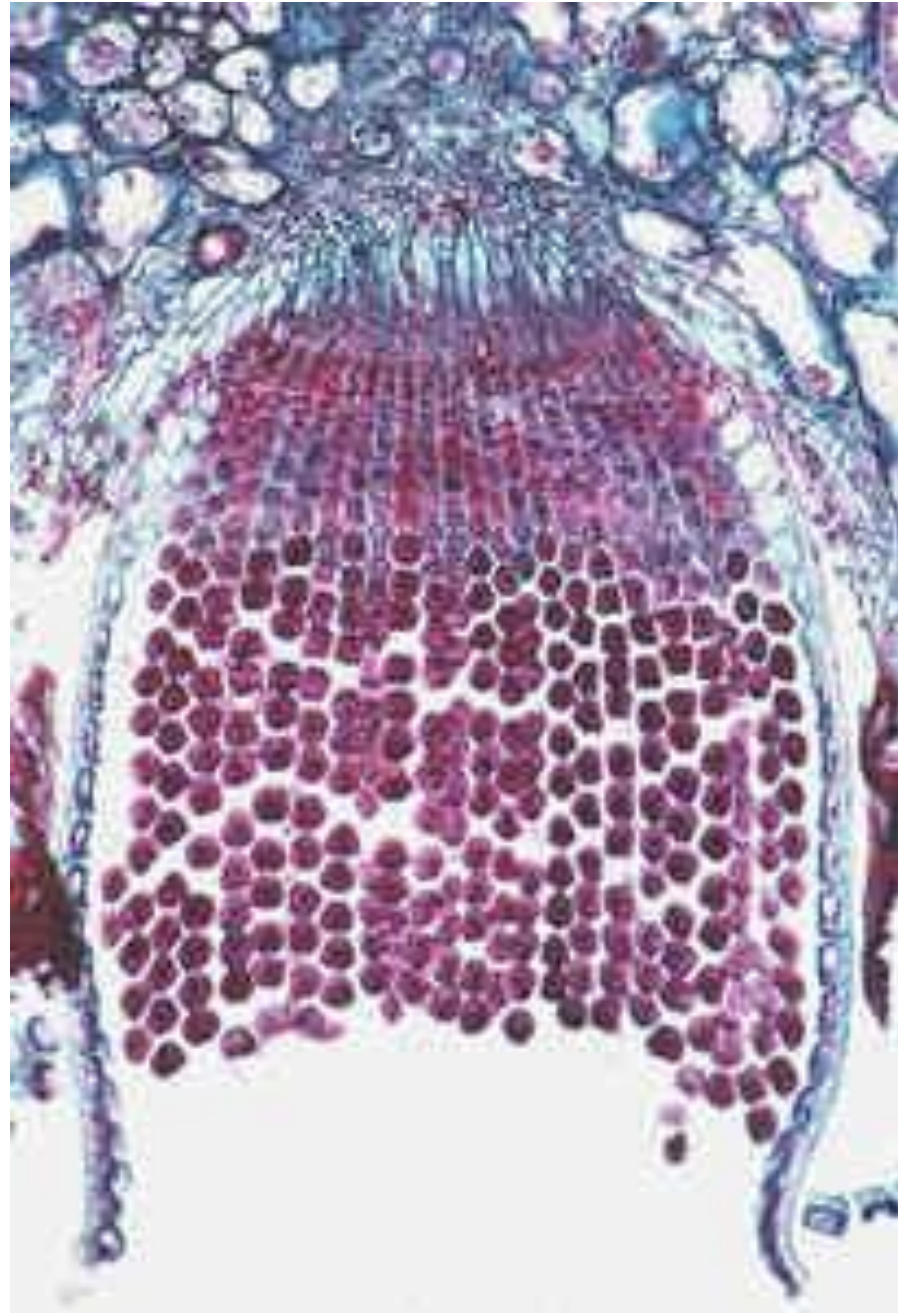
Teliospores 400x



Two-Celled Dikaryotic Spores That
Germinate in the Spring







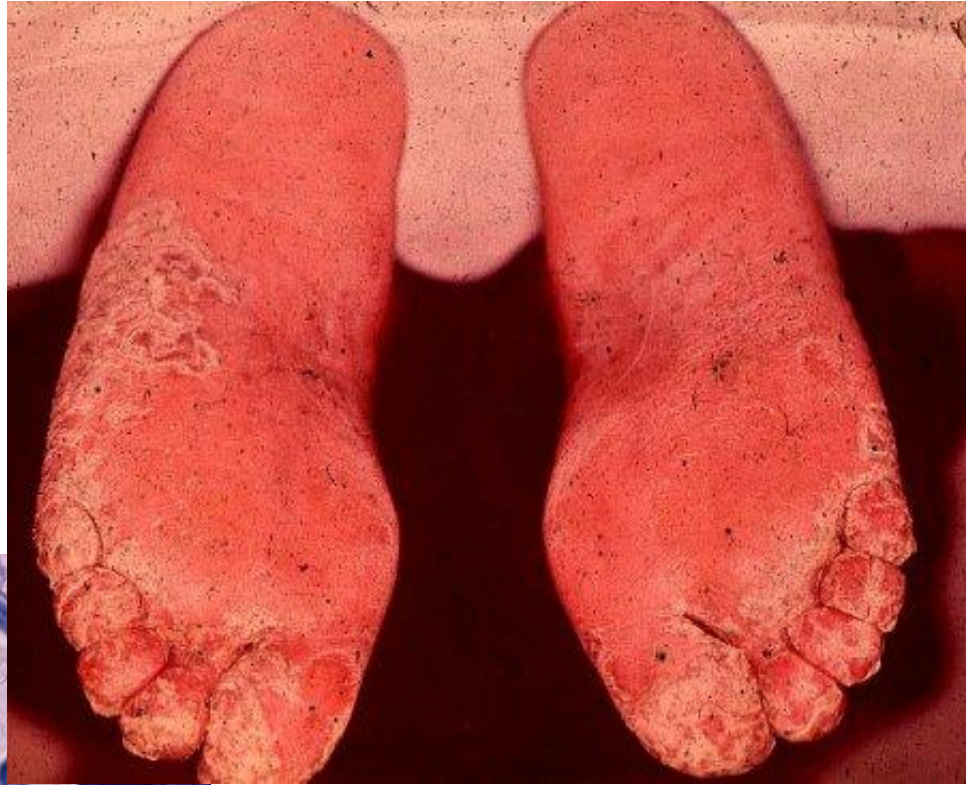
5- Class: Deuteromycota

- Called **fungi imperfecti**.
- Don't have sexual state in their life cycle.
- The mycelium is **septated**.

Deuteromycetes

The Deuteromycota is a heterogeneous group of unrelated species in which sexual reproduction has never been observed. Since mycologists refer to the "perfect phase" of a life cycle as the phase in which sexual reproduction occurs, these fungi are often referred to as imperfect fungi. These fungi may have lost their sexual phase through the course of evolution. Alternatively, biologists simply may not have found the appropriate environmental conditions to observe development of the sexual phase of their life cycle.

Trichophyton



Ecology of Fungi

- Mutualistic associations
 - lichens - fungi and green algae
 - mycorrhizae - fungi and plant roots

Lichens

- Lichens are symbiotic associations between a fungus and a photosynthetic partner.
 - usually ascomycetes
 - Specialized fungal hyphae penetrate photosynthetic cells and transfer nutrients to fungal partner.
 - Durable fungus, combined with photosynthetic properties, has enabled lichens to invade harsh climates.
 - extremely sensitive to pollutants

Thank you

